Forests of British Columbia

H. N. Whitford and R. D. Craig

Commission of Conservation
Canada

Commission of Conservation

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Commission of Conservation
Canada

COMMITTEE ON FORESTS

FORESTS OF BRITISH COLUMBIA

BY

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Under the direction of
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OTTAWA, 1918

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Note.—As a very comprehensive Index has been inserted at end of the volume, the Table of Contents has been abbreviated to a list of chapter headings, maps and illustrations.

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Page 22 Twenty-third line from bottom, for *760,000*[2], read *368,400*[2].

Seventeenth line from bottom, for *13,539*[4], *8,202*[2], read *13,593*, *8,202*.

Fifteenth line from bottom, for *7,680*[2], read *3,684*[2].

Eleventh line from bottom for *pp. 4 and 5. The figure 7,680*, read *pp. 2 and 3. The figure 3,684.*

Sixth line from bottom, *delete entire line.*

" 23 Tenth line from top, for *nearly twice*, read *four times.*

Nineteenth line from bottom, for *400*, read *366.*

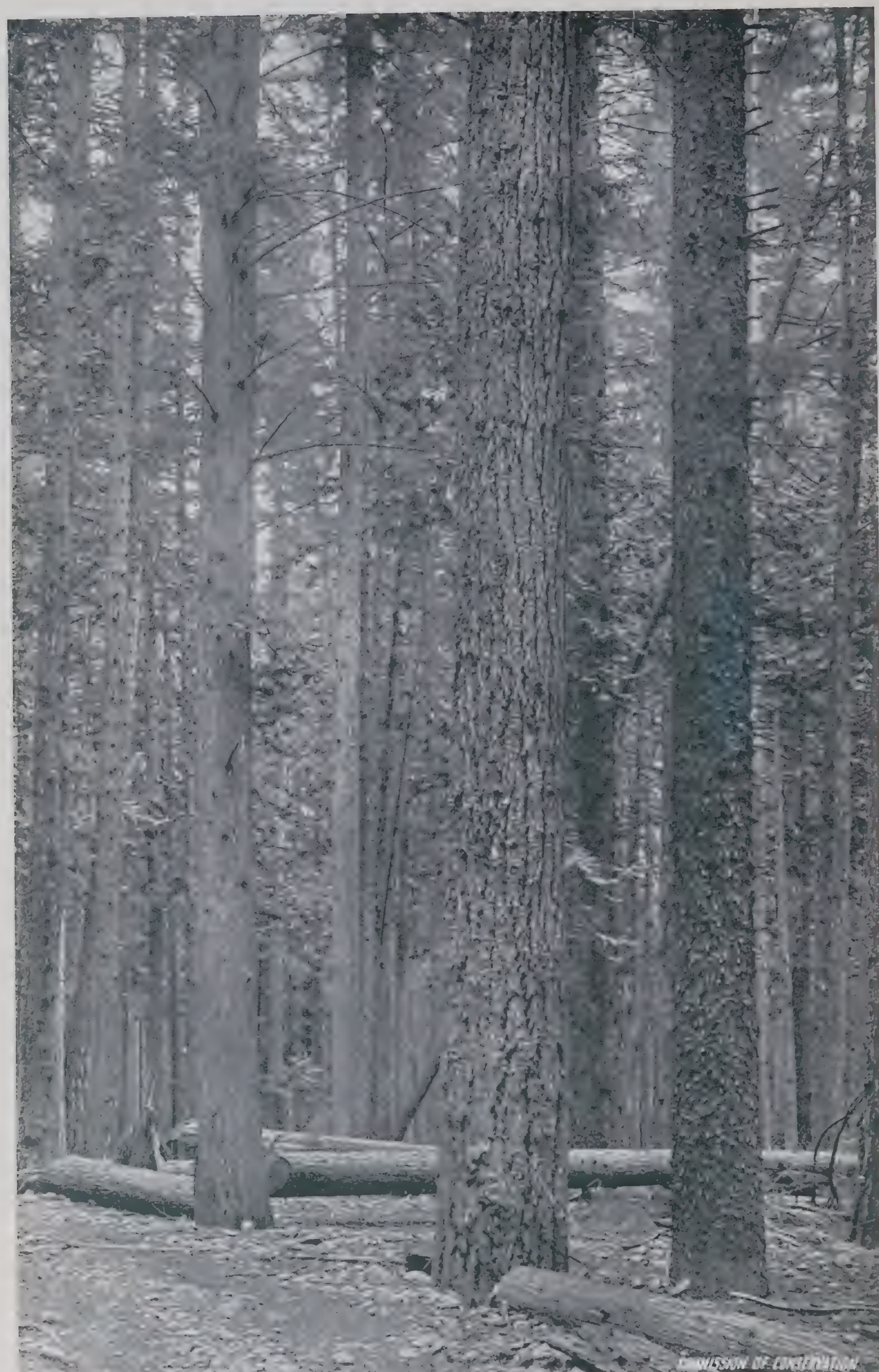
Eighteenth line from bottom, for *26*, read *24.*

Sixteenth line from bottom, for *24 per cent, or 250*, read *16 per cent, or 230.*

" 26 Third line from bottom, for *Government Relations*, read *Land Tenure in British Columbia.*

" 62 Eighteenth line from top, for *Western Hemlock-Balsam Type*, read *Western Hemlock-Amabilis Fir Type.*

Plate I



Red Cedar Douglas Fir Sitka Spruce

A YOUNG FOREST ON THE PACIFIC COAST

THE FOREST RESOURCES OF BRITISH COLUMBIA

Introduction

AT no time in the history of Canada has a knowledge of our resources been of such vital importance. During the course of the great war, the resources of the Allies, in men and materials, are being mobilized to an extent which would have been considered impossible in antebellum days. The force of these resources, marshalled from almost every part of the world, is beginning to be felt on the line of battle, and will in the end be the determining factor in the conflict. Unprecedented expenditures have been made to meet the war's demands, and obligations have been incurred by all the belligerents which must be met by present and future industry. The share of the burden which Canada is assuming is not a light one for this country, in its present stage of development. The success which has attended her call for financial credit is attributable, directly, to the belief that, by the development of her natural and industrial resources, she will be able to meet all her obligations.

Addressing the Eighth Annual Meeting of the Commission of Conservation, in January, 1917, the Chairman, Sir Clifford Sifton, drew attention to the manner in which the necessity for conservation—for national efficiency—has been impressed by the war upon all peoples, belligerent or neutral :

"Among the most remarkable results of the war has been the re-examination which each nation has been compelled to make with regard to its material resources. The gospel which we have been preaching for some years past has now been found to be the true gospel. It has been found by hard experience that national safety demands that nations should not only possess resources but understand them and be able to utilize them economically. Whereas, a few years ago people listened to the discussion of this subject with polite but somewhat academic interest, they now know that no subject is of more importance to the national welfare, and that the lack of developed capacity to utilize every possible resource may, in certain emergencies, mean disaster."

Canada, during recent years, has made great advances toward the investigation and proper utilization of the natural resources of the Dominion, yet it has, nevertheless, steadily become more apparent, as the work of the Commission of Conservation has progressed, that the economic problems awaiting solution are of a magnitude to require unremitting study and practical effort.

All the efforts of the Dominion must be devoted to production and economy. The vast resources of Canada, to which the term 'illimitable' has been so frequently applied, because of lack of knowledge, must be turned to some useful purpose. Untilled fields, buried minerals or standing forests are of no value except for the wealth which, through industry, can be produced therefrom.

That industry may be intelligently applied, a knowledge of the natural resources upon which it depends is fundamental. It is poor economy to attempt to develop an industry the basic materials for which are not available in sufficient quantities to ensure successful operation.

In the development of the resources supplied by nature, two classes must be recognized—the reproducible, such as products of the soil, and the non-reproducible, such as minerals. Too frequently the forests are considered in practice as belonging to the latter class. The supplies of timber which are available for present use are necessarily of more immediate interest, though, ultimately, the productivity of the soil is of primary importance. The extent of the land in Canada which is available for forest production, and for that purpose only, is not generally realized. Agriculture, where possible, is the most profitable use of the soil, but the area in Canada which can be so utilized is small compared with the area of absolute forest land. In British Columbia, only about 5 per cent of the total area appears to be suitable for agriculture. A very high percentage of the remainder is chiefly valuable for the production of timber. Beyond question, the best interests of the province, and of the Dominion as a whole, demand that this vast area of non-agricultural land be devoted to the systematic production of successive crops of timber.

The value of the forest production is shown by the following statement of the products from the four primary industries in Canada for the year 1915:*

Field crops	$797,669,500
Forests	172,880,000
Mines	138,513,750
Fisheries	31,264,631
Total	$1,140,327,881

The year 1915 was one of general depression in the lumber industry, therefore a very material increase in forest production is assured. There is no doubt that, with protection from forest fires and with the enforcement of adequate cutting regulations, the forests of Canada could be made to produce many times the present amount. New industries are developing which call for new materials, frequently for those which were formerly wasted and considered of no commercial value. The pulp industry, for instance, utilizes species and qualities of timber which were disdained by the pine lumberman, and, on many areas, a second cutting has been more profitable than the first. A reasonably accurate knowledge of the character and extent of the forest resources of the country is obviously necessary, in order that all of the forest may be utilized to the best advantage practicable, and that adequate plans may be made for present and future development.

In British Columbia, which is supposed to possess about one-half of the saw material in the Dominion, the lumber industry ranks with mining as the most important primary industry. The values assigned to the various industries for the last four years are as follows :

VALUE OF BRITISH COLUMBIA PRODUCTS

	1913	1914	1915	1916
Forest	$33,650,000	$28,680,000	$29,150,000	$35,528,000
Mines	30,296,398	26,388,825	29,447,508	42,970,555
Fisheries	14,455,488	13,891,398	11,515,086	14,538,320
Agriculture	26,222,033	30,184,100	31,127,801	32,259,157

*_Canada Year Book_, 1915.

In addition to the industrial wealth created by the exploitation of our forest resources, the forests constitute one of the chief sources of direct revenue to the various governments.

In 1915, the Dominion and Provincial government revenues derived from the forests aggregated over $6,000,000. The forests of British Columbia contributed a larger revenue than those of any other province ; the revenue collected by the Federal Government, in the Railway Belt, being $89,277, and that by the Provincial Government, $1,922,558, making a total of $2,011,835 for British Columbia, or approximately one-third of the total forest revenue of all Canada.

Since its organization, in 1910, the Commission of Conservation has devoted much effort toward obtaining information in regard to the forest resources and forest conditions of Canada ; and, in presenting this report on the forests of British Columbia, it is felt that a valuable addition has been made to the knowledge of the forest wealth of the Dominion. Previous forestry publications of this Commission include a report on the forest conditions of Nova Scotia, by B. E. Fernow, LL.D., assisted by C. D. Howe, Ph.D., and J. H. White.* A somewhat similar report on the Trent Valley watershed, Ontario, *Trent Watershed Survey*, has also been prepared and published by the Commission, as well as reports on *Forest Protection in Canada* for the years 1912, 1913 and 1914.

The results of an investigation into the forest resources of Saskatchewan will shortly be issued by the Commission, and it is hoped that similar reports for other provinces may be prepared as rapidly as funds can be made available for the prosecution of the necessary field work. In particular, it is expected that an investigation into the forest resources of Ontario will be begun at an early date. For this important project, the co-operation of the Provincial Government has been assured. New Brunswick is conducting a comprehensive survey of its forests, which will be a valuable basis for forest administration in that province. Of the forest resources of Ontario and Quebec, only fragmentary and conflicting data are available as yet.

The phenomenal development of the pulp and paper industry in eastern Canada, due to the rapidly approaching exhaustion of the pulpwood resources of New York and the New England states, calls for an immediate investigation of the available supplies of pulpwood and the means whereby the industry may be made permanent. This is a project to which the Commission is giving considerable attention.

Alberta, Saskatchewan and Manitoba possess extensive forest areas of great local value. The Dominion Government has set aside some 21,270,000 acres in the three Prairie Provinces for permanent forest purposes, in addition to some 4,248,000 acres for Dominion parks in Alberta. Large additional areas, found, upon examination, to be non-agricultural, and chiefly valuable for forest production, have been withdrawn pending final establishment as forest reserves by Act of Parliament.

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*The cost of the field work in connection with this report was borne by the Government of Nova Scotia.

Three years were spent by the authors in compiling the data necessary for this report and, as far as possible, a personal knowledge of the local conditions in each district has been secured. The greatest difficulties experienced in conducting this investigation were due to the large extent of territory to be covered, the extreme variability of the forest conditions, and the difficulty of establishing a standard for timber of commercial value.

The province contains approximately 355,855 square miles, 2,439 square miles of which is covered by lakes, leaving a net land area of 353,416 square miles. Much of the province has not, as yet, been explored with any degree of thoroughness. Lacking transportation facilities, even in the form of trails, time did not permit of the examination of many of these remote regions personally, but it was usually possible to secure reliable information concerning these districts from officers of the Provincial Forest Branch, surveyors, prospectors, trappers or others who had a local knowledge of the conditions.

British Columbia has been referred to as a 'sea of mountains,' or a 'land of valleys,' depending upon the viewpoints of the writers. These appellations agree, however, in presenting a picture of uneven surface—an unending succession of elevations and depressions. The unevenness of contour has such a marked influence on the climatic conditions that the vegetation varies from the almost tropical luxuriance of the southern coastal region to the semi-arid, cactus and sage-brush growth of the Interior plateau. Extreme altitudinal variations, together with a wide latitudinal range (11 degrees of latitude), produce, also, marked modifications in the conditions of plant life. It has been estimated that the average altitude of the land in the province is over 3,500 feet, so that a large portion is above the limit of arborescent growth. The roughness of the topography contributes also to the variability of the forests.

To arrive at an estimate of the forest resources, it was first necessary to determine, as accurately as possible, the area which, on account of high altitude or unfavourable soil conditions, cannot be expected to produce forests of commercial value. It is difficult to distinguish between permanently unproductive lands and those rendered so by adventitious causes, such as fire, wind, floods or slides. The timber line attains its highest altitude in the southern interior portion of the province, where it extends to about 6,000 feet. On the coast it is considerably lower, being about 3,500 feet on Vancouver island, and falling to 1,500 feet in the vicinity of Portland canal. Local soil and topographical conditions have a marked effect on the altitudinal limit of tree growth and, in favoured situations, good stands are sometimes found above these altitudes, but, more frequently, the merchantable stands do not attain these elevations. Almost three-fifths of the terrain in British Columbia must be classed as unproductive, from a forestry point of view.

The unevenness of the topography, and the diversity of the soil and climatic conditions, result in extreme variation in the forests. In the moist valley bottoms along the coast, stands yielding over 100,000 feet board measure per acre are prevalent, while, frequently, treeless, alpine conditions exist within a mile of such stands. On almost any well timbered square mile on the coast some part of the area will carry at least 50,000 feet per acre, and, on a con-

siderable proportion of the land, no merchantable timber will be found. This unevenness of stand precludes the adoption of any wholesale method of estimation on the coast. In the interior of the province, however, and especially in the plateau country between the Coast and Rocky Mountain systems, more uniform stands are found over large areas. Forest types, based on the average yield, can, therefore, be distinguished and used as the basis of estimating the total stand in these regions.

One of the chief difficulties in preparing any estimate of forest resources has always been to arrive at a suitable definition of 'merchantable' timber. Standards vary in different parts of the province in regard to the species, qualities and sizes of timber which can be used, and the difference in the standards between eastern Canada and British Columbia is very marked. The market and exploitation facilities determine, to a large extent, whether timber is of commercial value. In the southern interior of the province, where the timber is small and can be handled by horses and driven down the streams to the manufacturing points, which are close to the markets of the Prairie Provinces, timber can be profitably exploited that would be of little or no value in the heavy stands on the coast. On the other hand, the establishment of pulp mills on the coast has changed the standards of timber estimating very materially in the last ten years. Prior to that time, hemlock and balsam were ordinarily omitted from the timber cruiser's estimates. Standards vary with the demands of the lumber market. If the demand for any species, such, for example, as cedar, increases to the point where it is difficult to fill it with the superior grades, the smaller sizes and poorer qualities which, previously, had no commercial value, can be utilized.

The accessibility of a tract of timber is a relative term, depending on many factors besides the actual situation. The development of transportation and logging equipment has brought into the market large amounts of timber which was, at one time, considered commercially unavailable. The most important factor in availability is, however, the price of the product, and, as wood values increase, more timber will become available for exploitation. There is a large amount of timber in British Columbia so situated that, at present, it would cost two or three times the sale value of the logs to bring them to a market. On the other hand, many tracts which, a few years ago, possessed a negative value for operating purposes, are now being profitably operated. Since it is impossible to foresee the developments which may take place in the future, the question of present accessibility was disregarded in the preparation of this report and, therefore, the figures given do not represent the forest resources available for immediate use, but the amount on the land which may be utilized when conditions permit.

Effort has been directed to avoid making undue allowance for the waste which, at present, prevails in lumbering operations in British Columbia, though many of the old cruises from which the total estimates were derived were based on 'experience' or 'utility' standards.

The later and more scientific timber cruises are, however, made on a total wood volume basis, which includes all the timber of a utilizable size, usually to

a minimum diameter limit of 10 inches on the stump, and leave to the discretion of the operator the degree to which he will utilize the stand. As far as possible, this standard has been adopted.

The estimates of the stand were compiled from detailed reports furnished by the British Columbia Forest Branch, the timber owners, cruisers, surveyors and others, who generously co-operated with us in conducting this investigation. In response to a request from the Commission of Conservation, the timber owners very generously furnished a wealth of detailed information, which could not have been secured otherwise without many years of field work and an absolutely prohibitive expenditure. These cruisers' reports were supplied by the timber owners on the understanding that they would be treated as confidential by the Commission. In addition to the data secured from the timber owners directly, numerous reports were secured from other sources. As, frequently, two or more reports on the same tract were secured, it was possible, with the authors' personal knowledge of local forest conditions, to check a considerable portion of the data collected. Detailed reports on the amount of each species of timber were secured for approximately 75 per cent of the alienated forest lands, but the reports for 10 per cent of the area were discarded as valueless. Reconnaissance surveys have been conducted by the Forest Branch over several large areas, mostly in the interior, and these were of great value in the preparation of this report.

It is recognized that cruisers' reports are not always reliable, since there is no such thing as absolute accuracy in estimating standing timber. The personal qualities of the cruiser, as well as the purpose for which the report is made, are important factors. The most frequent source of error on the part of cruisers is their failure to properly estimate the area carrying timber. As a rule, the older cruises were found to be lower than the recent and more carefully made estimates, the latter more nearly approaching a wood volume basis, while the former included only such timber as the cruiser considered could be profitably cut at the time. This resulted frequently in the omission of the hemlock and balsam and of all trees under about 24 inches in diameter, breast high, and of the less accessible timber. Very heavy stands were, as a rule, under-estimated, and light stands were over-estimated. The application of modern forestry methods in cruising has resulted in more accurate results being obtained.

For descriptive purposes, the province has been divided into 66 districts, which have been designated 'drainage areas,' though, frequently, the boundaries of these districts were determined by other considerations than drainage. Uniformity of climatic, silvicultural and managerial conditions were considered important factors in this connection. Twenty-six of these districts are situated on the coast, and forty lie to the east of the Coast mountains. An attempt has been made to classify the land in each district, showing not only the area covered by merchantable timber but the area which should be devoted to forest production.

It has been found that, of the total land area of the province, 355,855 sq. miles, approximately 200,000 sq. miles is incapable of producing forests of com-

SHIPS LOADING LUMBER FOR EXPORT, VANCOUVER

SAWMILLS OF THE CANADIAN WESTERN LUMBER CO., AT FRASER MILLS

mercial value. About 145,000 sq. miles lie above the merchantable timber-line, and on 55,000 sq. miles, though below timber-line, the soil is either too rocky or wet, or the forests have been so completely destroyed by fire that there is no hope for the natural re-establishment of forest conditions for centuries to come.

Of the remaining 155,855 sq. miles which is capable of producing forests, only about 28,000 sq. miles—less than one-fifth—carries sufficient timber to be classified as statutory timberland.* In the interior of the province there are areas of forest land, aggregating 23,800 sq. miles, which, though not reaching this standard, carry between 1,000 b.f. and 5,000 b.f., part of which may be utilized. Only very meagre data have been obtained, as yet, as to the area of land which can be used for agricultural purposes. It appears from our forest land classification that somewhat over 5,000 sq. miles is grass land or very open forest, some of which is suitable for cultivation, but the greater proportion is of value only for grazing. In addition, there is, perhaps, from 12,000 to 15,000 sq. miles cleared or under forest which is, or may be, more valuable for agriculture than for forest production. Deducting this potential agricultural land, say 20,000 sq. miles, from the land capable of producing commercial timber, there is 135,855 sq. miles of absolute forest land which should be devoted permanently to forest production.

The timber on about 100,000 sq. miles, or two-thirds of the land once forested, has been totally destroyed by fire, and on over half of the remaining 55,855 sq. miles the timber has been seriously damaged. Using the timber still standing as a basis, it is estimated that the province has lost, through forest fires, at least 665 billion feet board measure. When one considers that the total stand of saw material in the whole Dominion probably does not greatly exceed this amount now, the seriousness of this loss, which can be attributed very largely to public carelessness, becomes apparent.

Following table indicates composition of the present stand of saw material:||

Species	Coast		Interior		Total	
	Million feet board measure	Per cent	Million feet board measure	Per cent	Million feet board measure	Per cent
Western red cedar..	59,000	27·4	18,019	13·2	77,019	22·1
Douglas fir........	64,000	29·4	12,573	9·2	76,573	21·8
Spruce†...........	14,000	6·7	58,375	42·8	72,375	20·6
Western hemlock...	52,000	24·6	12,164	8·9	64,164	18·3
Balsam‡...........	19,000	9·2	13,838	10·2	32,838	9·5
Lodgepole pine.....	20	·1	12,130	8·9	12,150	3·5
Western yellow pine	......	...	4,208	3·1	4,208	1·2
Yellow cypress.....	3,700	1·9	.....	...	3,700	1·1
Western larch......	......	...	3,152	2·3	3,152	·9
White pine........	1,100	·5	1,617	1·2	2,717	·8
Black cottonwood ..	400	·2	272	·2	672	·2
	213,220	100·0	136,348	100·0	349,568	100·0

*The Land Act defines 'timberland' as that which, when situated west of the Coast mountains, carries at least 8,000 b.f. per acre ; when east of the Coast mountains, 5,000 b.f. per acre.

†Includes Sitka spruce, Engelmann spruce, white spruce and black spruce.

‡Includes alpine fir, lowland fir and amabilis fir.

||Total stand of saw timber and pulpwood material is 366 billion feet (see p. 11). For details see Chapters II and III, Part II.

It will be seen from this that, of the species which are used in the manufacture of pulp and paper (hemlock, balsam, spruce and cottonwood), there is 170 billion feet, which is equivalent to 243 million cords* of pulpwood, which may be increased to 250 million cords by utilizing smaller sized timber. In view of the fact that the supply of pulpwood is becoming a very serious matter in eastern North America, it is of interest to know that so considerable a supply may be obtained in British Columbia.

The estimate of the forest resources of the province submitted in this report is based on a much higher percentage of detailed timber cruises than any forest report of a similar nature heretofore issued. It is believed, therefore, that the information will be valuable, not only to the governments, which control the forest policy in the province, but to timber owners as well, and to financial interests, on whom the development of our industrial production so largely depends.

Although the primary object of this investigation was to secure an estimate of the available supply of timber in the province, it is felt that a report of this kind would not be complete without at least a general discussion of the conditions affecting the administration and utilization of the forests. In the opening chapters the geographic, physiographic and climatic relations, which affect not only the composition of the present stand, but also determine the character of the succeeding crops, are treated at some length. Under the head of 'Governmental Relations,' the various forms under which the forests have been alienated are described and the present systems of administration and protection of the forest are discussed.

The administration of the lands and forests in the province is divided between the Dominion and Provincial Governments. The Provincial lands which were transferred to the Dominion in connection with the building of the Canadian Pacific railway constitute a strip across the province extending 20 miles on each side of the main line of that railway and also a block of approximately 3,400,000 acres in the Peace River district. Though some timber-land has been sold outright, the general policy of both governments has been to dispose of the timber separately from the land, by granting leases or licenses, for which an annual ground rent and a royalty on the timber cut are charged. By this system, the government retains an interest in and a measure of control over the standing timber. As a consequence of the boom which prevailed in regard to western timber during the period between 1903 and 1907, about 15,000 sq. miles of provincial land was taken up under what is known as special timber licenses. Though over 2,000 of these have been subsequently abandoned, the license system has been one of the most important sources of provincial revenue. No provincial timber was reserved from alienation until the close of 1907, when the license system was discontinued. As a result of the policy hitherto followed, over three-quarters of the timber of commercial value in the province has been alienated under one form of tenure or another. As might be expected, these private holdings include the most accessible and most valuable timber in the province.

*In British Columbia 700 b.f. = 1 cord.

Timber was taken up far beyond the requirements of the lumber industry, and, unless production is greatly increased, the carrying charges on much of the less accessible timber will become a serious burden on the limit holders long before the timber can be used.

During the last five years the total cut in the province has averaged only 1,250 million board feet. With a stand of 350,000 million board ft. of timber of commercial size, and with over 100,000 sq. miles of land on which young forests are established and which, if protected, should produce from 5,000 million to 7,000 million board ft. per annum, it will be seen that the forest resources of British Columbia can, under conservative exploitation, supply at least five times the present cut without seriously depleting the capital stock.

It is a matter for congratulation that both the Provincial and the Dominion Governments are providing increasingly effective protection for the forests in the province. It is most encouraging that an increasing measure of public co-operation is being secured through the efforts of the Forest Service, in educating the citizens as to the value of their forests, and it may confidently be anticipated that the ruthless destruction of this wonderful heritage, which has caused such incalculable damage in the past, will, in future, be reduced to a minimum.

CHAPTER I

Geographical Relations

GEOGRAPHICAL position determines to a very large extent not only the kind and amount of forest products which can be produced, but the degree to which these products can be utilized. Upon the latter depend the extent to which lumbering can be carried on, and the intensity with which forestry can be practised.

British Columbia is a part of what is considered the greatest forest region in North America, the Pacific Northwest. For the purpose of this discussion this region may be defined as consisting of the states of Washington, Oregon, northern Idaho, western Montana, the 'pan-handle' of Alaska, and that part of British Columbia lying west of the axis of the Rocky mountains.* It extends from the 42nd parallel of latitude on the south to the 60th parallel of latitude on the north, and from the Rocky mountains on the east to the Pacific ocean on the west.

With the exception of the 'pan-handle' of Alaska, British Columbia occupies all of this region north of the 49th parallel of latitude, and has an area of 355,855 square miles.

Relation of Geographical Position to Forest Growth

The peculiar position of the Pacific Northwest in relation to the Japan and Arctic currents is responsible for the distinguishing characteristics of the climate. The warm, moisture-bearing, westerly winds blowing from the Japan current across the colder Arctic current, which comes from Bering sea and hugs the shore line more closely, give the entire Pacific Northwest a rainfall and temperature favourable to the production of what is perhaps the greatest coniferous forest in the world. This forest supplies wood especially suitable for general construction purposes and, consequently, is in the greatest demand in the markets of the world. The principal commercial species of this forest is Douglas fir, which attains a size excelled only by the redwood and giant trees of California.

A rough estimate of the standing timber in this region is 1,523 billion feet board measure. Of this amount about 366 billion feet is found in British Columbia.

The Pacific Northwest forest can be roughly divided into two distinct belts, one west of the Coast-Cascade mountains and the other east of these mountains. The former is known as the Coast forest belt, and, owing to its milder climate and greater rainfall, contains 68 per cent, or more than two-

* The northeast corner of British Columbia, comprising about one-sixth of its area, is situated east of the axis of the Rocky mountains.

thirds, of the entire amount, or 1,022 billion feet. Of this, 230 billion feet, or 22·5 per cent, is in British Columbia. The bulk of the timber of the Coast belt is situated south of the northern end of Vancouver Island and thus lies between the 42nd and 51st parallels of north latitude.

The Interior forest belt, known locally as the 'Interior' or 'Mountain' Forest region, is situated between the axis of the Coast-Cascade mountains on the west and the axis of the Rocky mountains on the east. This region carries a total of 500 billion feet of standing timber, 136 billion feet, or 27 per cent, of which is in British Columbia. The bulk of the timber in the Interior forest belt lies south of the 55th parallel of latitude, well towards the Rocky mountains and separated from the Coast forest belt by a semi-arid belt about 150 miles in width. (See Stand Type map accompanying this report.)

The situation above discussed will be more clearly understood by reference to the following table, which shows, in round figures, the best information available.*

TABLE 1.—STANDING TIMBER OF THE PACIFIC NORTHWEST FOREST†

(In billion feet, board measure)‡

	Coast belt		Interior		Total	
	Stand	Per cent	Stand	Per cent	Stand	Per cent
British Columbia........	230	22·5	136	27·1	366	24·0
Northwestern States......	792	77·5	365	72·9	1,157	76·0
Total..............	1,022	100·0	501	100·0	1,523	100·0

Relation of Geographical Position to Utilization

The forests of the Pacific Northwest contain large quantities of timber ready to be cut which cannot, at the present time, be fully utilized, owing to the great distance of the Pacific Northwest from the principal markets of the world. The chief markets are situated in the eastern portion of North America and in western Europe. Their timber supply, so far as imports are concerned, comes mainly from forest regions situated on or near the Atlantic seaboard.

The most important markets for the forest products of the Pacific Northwest are those situated on or near the Pacific seaboard and in the adjacent prairie regions east of the Rocky mountains. These markets, at the present time, are incapable of absorbing more than a portion of the possible cut of the Pacific Northwest. It is important, therefore, to consider the possibilities of an extension of the markets of the Pacific Northwest, and of British Columbia in particular. This problem involves such factors as the existing conditions

* For the situation in the United States, see 'Some Public and Economic Aspects of the Lumber Industry,' by W. B. Greeley, Assistant Forester. *Report No. 114*, U.S. Department of Agriculture, 1917.

† These figures do not include the 'pan-handle' region of Alaska, the forest wealth of which is estimated at approximately 70 billion feet.

‡ The term billion feet, where used throughout this report, signifies thousand million feet, board measure.

respecting manufacturing capacity, the competition of other forest regions and the possible limitation of the cut to an amount which will not endanger the forest capital.

Present Cut

The following table shows the cut of the forest region under discussion for the year 1913 :

TABLE 2.—LUMBER CUT OF THE PACIFIC NORTHWEST FOREST FOR THE YEAR 1913*

(In million feet, board measure)

	Coast belt		Interior		Total	
	Amount	Per cent	Amount	Per cent	Amount	Per cent
British Columbia.........	781	8·8	375	4·2	1,157	13·0†
Northwestern States	6,145	69·2	1,575	17·8	7,720	87·0‡
Total..............	6,926	78·0	1,950	22·0	8,877	100·0

Of the total cut of 8,877 million feet of lumber in the Pacific Northwest region in 1913, 1,157 million feet, or only 13 per cent, was cut from the forests of British Columbia, although nearly 26 per cent of the total standing timber of the region is situated within the province. Of the British Columbia cut, approximately two-thirds is from the Coast belt and the remaining third from the Interior.

Possible Cut

To maintain the forest capital intact the annual cut must not exceed the annual growth. In British Columbia it is very much less than the amount which could be cut without endangering the productive capacity of the forest. British Columbia is so large and contains so many different site classes that it is difficult to make anything more than a rough estimate of this growth. Moreover, the probable loss from fires must be considered. Again, where natural regeneration is depended upon for reforestation, all degrees of restocking occur ; fully restocked areas are the exception rather than the rule. Also, a certain percentage of the area forested with merchantable stand contains mature and overmature timber where the decay approximately offsets the increment.

Selected areas on the Coast that were fully restocked have been found to produce an annual increment of 1,000 board feet per acre in forty years' growth. Obviously, this figure is much too high for a general average, even for the

* It has been thought advisable to use the statistics of the year 1913 throughout this report, because 1913 was the last of a series of years of rapid development in the lumber industry of the Pacific Northwest. As 1913 was the 'peak' year of production, saw-mill capacity and shipments, the timber output of that year must be surpassed if the lumber industry is to continue to develop. Hence, for the sake of the argument that follows, the statistics of 1913 are used rather than the average of a number of years. In many ways, 1913 will represent a milestone in the history of forestry and of the lumber industry of the Pacific Northwest.

† See 'Forest Products of Canada, 1913.' Compiled by R. G. Lewis, *Bulletin No. 48*, Department of the Interior, Forestry Branch, Canada, page 10.

‡ Compiled from 'Production of Lumber in 1913,' *Bulletin No. 232*, Forest Service, U.S. Dept. of Agriculture, Washington, D.C., 1915. See also 'Some Public and Economic Aspects of the Lumber Industry,' by W. B. Greeley, Assistant Forester, *Report No. 114*, U.S. Dept. of Agriculture, 1917.

Coast, where the rate is exceedingly high as compared with the Interior. Taking the foregoing factors into consideration, it has been assumed that the average annual increment might be estimated at 100 board feet per acre, over approximately 50,000,000 acres of comparatively accessible timber-land, under reasonably effective protection from fire. This assumption will give five billion board feet as the total average annual increment for British Columbia, and consequently this amount could be cut annually without endangering the present forest capital. This is approximately five times the actual annual cut. The results of the investigations embodied in this report show that there are 95,580,000 acres that are capable of producing merchantable timber, but a large part of this area is commercially inaccessible at the present time. With the development of transportation lines, large areas, especially in the Interior, will become more accessible. On the whole, therefore, the estimate of five billion feet is considered conservative.

Capacity of Saw-mills

The saw-mills of British Columbia were estimated in 1914 to have an annual capacity of 2,555 million board feet.* As the cut for the highest year, 1913, was only 1,157 million feet, the present saw-mill capacity of the province is more than double the amount of the actual cut. A similar situation prevails south of the international boundary, so far as the excess of mill capacity over annual cut is concerned. For the year 1914, the mills of the United States portion of the Pacific Northwest, including Northern Idaho, Eastern Washington and Eastern Oregon, had an estimated annual capacity of more than 13·6 billion feet, while the annual cut is only 6·8 billion feet. Thus, half the saws in the region in question must remain idle, for lack of a sufficient market for the product.†

This locking up of capital in mills and machinery was due partly to the over-confidence of the lumbermen in the ability of the markets to absorb lumber, and partly to the efforts of the millmen to realize quickly on their timber investments. In many cases, these efforts were forced by the pressure of economic conditions.

Disposition of the Cut

The markets for the timber of the Pacific Northwest can be divided into home, rail and water markets.

Home Markets—For the sparsely settled province of British Columbia, it is estimated that, during 1912 and 1913, about one-fifth of the timber cut was used locally. During 1914, however, the home consumption suddenly decreased to one-twentieth of the total cut of the province.‡ Probably under normal conditions 15 per cent of the total cut will be used at home, leaving 85 per cent to be disposed of outside the province.

Of the timber cut in the Coast belt of Washington and Oregon in 1913, approximately 25 per cent was consumed in the states of Washington, Oregon, Idaho and Montana,|| and, for the region between the Cascades and the Rocky

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* *Report of the Forest Branch of British Columbia, 1914*, p. 122.

† See 'Some Public and Economic Aspects of the Lumber Industry,' by W. B. Greeley, Assistant Forester. *Report No. 114*, U.S. Dept. of Agriculture, 1917.

‡ *Report of the Forest Branch of British Columbia, 1914*, p. 120.

|| *West Coast Lumberman*, Nov. 15, 1915, p. 23.

mountains, about 37 per cent of the production found a market in these states. In 1914 this proportion decreased to 31 per cent.*

The foregoing percentages, representing the last of a series of years of rapid development throughout the entire region, will perhaps not be equalled for a long time. While it is almost certain that there will be a steady increase in population for all the units of the region under consideration, thus increasing the absolute amount of timber used, yet it is probably safe to estimate that the consumption of the home market will not be more than from 20 to 25 per cent of the total cut.

The development of the Pacific Northwest will depend to a very large extent on the development of the lumber industry itself. In British Columbia the four leading industries are lumbering, mining, agriculture and fisheries. Forest production, primary and subsidiary, represents a very substantial proportion of the total wealth-producing capacity of the province, contributing, in 1913, nearly $34,000,000. The mineral resources and the activities of the fishing industry are confined to limited regions. The forest resources are, on the other hand, fairly well distributed throughout the province, contiguous to fertile valleys that need development. The establishment of mills and logging camps in such regions will induce an influx of settlers by giving them a ready market for their products and by furnishing them with employment during winter months until they become well established. Logging operations will aid also in clearing lands that are suited for agricultural development. The home markets for agricultural and forest products depend largely on mutual development. To a certain extent, therefore, the two industries are interdependent, and especially is this true in a newly-developed country.

Naturally, in a mountainous country like British Columbia, the amount of land suitable for agricultural purposes is small as compared with that adapted for growing timber. Even when all the agricultural land is fully utilized, it can never support a population that will consume more than a very small proportion of the forest products that the non-agricultural lands are capable of growing. Hence, the lumber industry, if it is to be developed fully, must always depend largely on outside markets.

Rail Markets—Approximately 75 per cent of the 1913 lumber cut of British Columbia was shipped out of the province by rail. While there are no figures showing the distribution of these shipments, the prairie markets of Canada absorbed most of the material. Small amounts reached eastern Canada, and some went to the United States.

The geographical proximity of the Pacific Northwest to the prairie region, with consequent lower freight rates, gives the products of these forests a great natural advantage over those from the eastern part of North America. The possibility of greatly increasing the markets in the prairie region is evident, owing to the fact that as yet only a comparatively small percentage of the available land in this region is being utilized. The prairie regions of Canada are likely to increase more rapidly in population than those of the United

* *West Coast Lumberman*, August 15, 1915, p. 20.

States, since, in the latter case, the greater proportion of the area is already settled.

The amount of lumber from British Columbia that reaches the markets of eastern Canada is small, partially because of the high freight rates, but also on account of the lack of a knowledge of the qualities of the Pacific woods. Shipments consist mainly of upper grades. Southern yellow pine has in the past supplied the markets of eastern Canada with the class of construction timber that cannot be furnished by the local forests. A strong impetus to the development of home markets generally has been given by the recent decision of the various Dominion Government departments and of the Canadian Pacific railway to give preference to Canadian timber in making contracts and purchases. In particular, it will mean a greater consumption of British Columbia lumber and construction timbers in the markets of eastern Canada.

The rail exports of British Columbia lumber to the United States have increased rapidly since the duty on lumber entering that country has been removed. This increase applies especially to cedar shingles and lumber.

Statistics of the distribution of rail shipments of the lumber cut in the coastal belt of Oregon and Washington show that Douglas fir lumber has invaded nearly every state in the Union. This is true as to even the southern states, in which southern yellow pine, Douglas fir's greatest competitor, is produced. These figures* are based on a production of six billion feet from the coastal belt of Oregon and Washington in 1913, and show that the region between the Rocky mountains and Chicago and south to Texas, and the states west of the Rocky mountains (except California), absorbed 39 per cent of the total cut. Twenty per cent of the cut, representing mostly cargo shipments, went to California, and approximately three per cent of the cut (partly cargo shipment) invaded the region east of Chicago and the states of Texas and Louisiana. The two last-named states, which furnish most of the southern yellow pine, took two and one-half million feet.

The foregoing figures show that the general use of Douglas fir in the eastern part of the United States is restricted by the high freight rates incident to the long-distant haul. When normal conditions again prevail, the establishment of lower rates by way of the Panama canal seems certain. This will mean that the consumption of Douglas fir in the eastern part of the United States will be greatly increased, and British Columbia will undoubtedly share in this market.

The United States portion of the Pacific Northwest has long been the chief competitor of British Columbia in the Canadian home markets, despite the tariff on finished lumber imported into Canada. While the figures given for timber shipments from the Pacific states to the prairies of Canada are conflicting, the actual amount for 1913 seems to have been about 200 million feet, as against some 700 million feet for British Columbia's share of this trade. Results in favour of British Columbia timber, as against that from the United States, have already been secured through the recent extensive educational

* See article in *West Coast Lumberman*, Nov. 15, 1915, p. 23.

campaign carried on in the prairie region of Canada by the British Columbia Forest Branch. The Provincial Government has established branch offices at Regina, Sask., near the centre of the prairie district, and at Toronto, Ont., from which information as to British Columbia woods and as to their prices and supplies are distributed to the trade.

THE WATER MARKETS—The water markets of the Pacific Northwest are of two general classes—the Pacific seaboard markets and the Atlantic seaboard markets.

The Pacific Seaboard Markets—The present cargo export trade of lumber from the Pacific Northwest to Pacific seaboard markets, while not large, has great possibilities of development. The following table shows that British Columbia, in spite of her great resources and large mill capacity, is not securing the share of this trade to which she is entitled:

TABLE 3.—CARGO SHIPMENTS FROM THE PACIFIC NORTHWEST COAST BELT TO PACIFIC SEABOARD MARKETS, 1913 *

(In thousand board feet)

Destination of shipment	From British Columbia ports	From United States ports	Total
California	1,420	1,236,630	1,238,050
Australia	10,100	228,670	238,770
China	450	105,970	106,420
West coast South America	4,820	118,820	123,640
Hawaiian Islands	......	54,450	54,450
Japan	4,720	16,470	21,190
South Sea Islands	1,000	10,890	11,890
Panama	.....	10,830	10,830
India	.....	10,570	10,570
New Zealand	650	7,960	8,610
Philippine Islands	.....	7,510	7,510
Mexico	.....	6,430	6,430
Central America	.....	70	70
Miscellaneous	5,010	3,250	8,260
Totals	28,170	1,818,520	1,846,690

Of the 1,846 million feet absorbed by the Pacific seaboard markets, British Columbia furnished about 1·5 per cent. If California, which is really a domestic market for the United States and a foreign one for British Columbia, be omitted, the latter furnishes more than 4 instead of 1·5 per cent.

All the timber that is shipped by water to Pacific ports is produced within the Coastal belt of the Pacific Northwest. A reference to Table 2 shows that British Columbia furnished 781 million feet of this cut and the United States supplied 6,145 million feet. Thus British Columbia contributed about 3·5 per cent of her total coast production to this trade, while the United States furnished more than 29 per cent. Again excluding California, the ratio is 3·5 to 10. The latter figures are in close proportion to the relationship existing

* These figures were compiled from an article in the *West Coast Lumberman* for March 15, 1916, pp. 32 to 35. Figures for 1913 are quoted for the reasons given in the footnote under Table 2, page 12.

between the total stand of timber in the Coastal belt of the Canadian and United States portions of the Pacific Northwest region.

A discussion of the conditions that give the United States the advantage at the present time, so far as output is concerned, is reserved for the heading entitled 'Relation Between the Two Political Divisions.' *

There are other forest regions on the Pacific ocean that are in competition, or are likely to become more so, with the Pacific Northwest. A consideration of these regions and of the possibility of present and future competition, especially with Douglas fir products of the Pacific Northwest, is in order in this connection :

Japan—Of the several countries on the Pacific seaboard, Japan alone enters into serious competition with the Pacific Northwest at the present time, especially in China, which is the best market of the East. In 1913, Japan supplied to China about 44 per cent. of the entire amount of soft woods imported into that country, while, in the same year, the Pacific coast furnished 49 per cent.†

Japan is at the same time a customer for a small amount of Pacific Northwest forest products of a character which she needs and lacks within the limits of her own empire. This consists mostly of large dimension Douglas fir. In 1913 Japan absorbed 21 million feet from Oregon, Washington and British Columbia, 16 million feet from the two first named and nearly five million feet from the latter. Thus, in this year at least, British Columbia secured a larger percentage of the trade in Japan, in proportion to her cut from the Coast forest, than did Oregon and Washington.

Japan husbands her forest resources more than any other country on the Pacific. It is improbable that she is, as yet, drawing on her forest capital in excess of the annual increment, unless it be in the outlying forests of the empire that are not yet under intensive management, and then only on lands that can be thrown open to agricultural development. However, with the enormous strides Japan is making industrially, she is likely to increase the amounts imported from the Pacific Northwest rather than to decrease them. At the same time, she has probably nearly reached the limit of the amount of soft woods she can furnish to China and other countries.

Western Siberia—North of Japan is the thinly-populated region of Western Siberia, which has considerable forest wealth. This wealth is not being utilized to the fullest capacity, and the probability is that the lumbering industry will not be fully developed for some time to come. It cannot be considered as an importing region, at least there is as yet no record of any shipments from the Pacific coast to that country. From the standpoint of the development of the lumber industry, the two seaboards of the Russian empire are analogous to the two seaboards of Canada and the United States. Until the forest resources of the Baltic seaboard of the Russian empire are fully

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* See page 25.

† See articles entitled 'United States Special Agent Reports on the Lumber Markets of China' in the *West Coast Lumberman*, Nov. 15, 1915, p. 21.

developed and show signs of exhaustion, there is not likely to be a very great development of her Pacific seaboard resources.

China—As already noted, Japan and the Pacific Northwest furnish nearly all the soft woods imported into China. Table 3 shows that the share of the Pacific Northwest in this trade amounted to 106 million feet in 1913, of which less than one million came from British Columbia.

The most promising Asiatic market for Douglas fir timber of all grades is in China. The amount that is furnished annually by the Pacific Northwest is only a small portion of what China will consume annually when she enters upon a more active construction of railways and develops commercially. While in Manchuria and in the eastern provinces of China there are apparently large areas of forests, but little is known of their extent or accessibility. To what degree they can supply the needs of an awakened China is problematic. Probably only a small share of the entire amount can be so furnished. There are no insurmountable difficulties in the way of British Columbia eventually obtaining her share of this trade.

India—The extensive forest area of British India is, for the greater part, managed conservatively, chiefly with the object of furnishing the immense population with its small amount per capita of wood consumption, and to favour the export of woods such as teak, which is used for special purposes. Coniferous woods occur at higher elevations in the Himalayas. These, with woods like sal and others, are the chief general construction woods, but the fact that India imported in 1913 about 11 million feet from the Pacific Northwest shows either that her forests cannot furnish a sufficient amount of general construction timber for her own use, or that the native woods are not adapted for certain special needs that can be filled by Douglas fir.

The fact that India is a part of the British Empire ought to be in favour of British Columbia obtaining a much larger part of the trade, and efforts are now being made in that direction. In 1913 British Columbia made no shipments to India, but in 1914 she sent about three million feet, mostly in the form of creosoted railway ties.

Philippine Islands—Recent investigations in the Philippines show that these islands have much more timber than is needed for local consumption, that a large proportion of this timber ranks equally well with Douglas fir for most construction purposes, and is still a fairly good substitute for even those purposes for which Douglas fir is superior. The importations of the Philippines have been gradually diminishing as the lumber industry of the country has developed. In time, the cheap construction timber of the Philippines will find an outside market.

Because of its geographic proximity, China is the most promising outlet to absorb the surplus lumber of the Philippines. If the efforts now being made to gain a footing in this market are successful, the Douglas fir timber of the Pacific Northwest is likely to find an active competitor in the woods from the Philippines.

Malay Regions—British and Dutch Borneo, Sumatra and the Federated Malay States are heavily timbered with forests similar to those of the Philippines. Modern logging and milling methods have only recently been introduced. If these countries were fully developed, they could furnish large quantities of timber that would come into keen competition with Douglas fir in Asiatic markets. The distributing point for this timber is Singapore, one of the largest timber markets in the East. The fact that Singapore imports no Douglas fir whatever is significant in this connection.

Australia and New Zealand—With the exception of California, Australia stands first in the amount of cargo shipments from the Pacific Northwest, and is, therefore, the most important off-shore market for the timber of this region. The chief native timbers of Australia are of the genus Eucalyptus. These woods are very heavy and hard, and are principally in demand for such construction purposes as paving blocks and railway ties, where great durability is required. While Australia has an export trade in these timbers, her imports far exceed her exports. In 1913, the shipments of lumber from the Pacific Northwest to Australia amounted to approximately 239 million feet, of which less than 14 million feet was supplied from British Columbia. Canada has failed to secure a larger share in this important market because the trade has been conducted almost entirely through agencies in the United States, which control not only the lumber market, but to a large extent, the shipping on the Pacific. Being a part of the British Empire, however, efforts are being made to foster the trade between Canada and her sister dominion. It is hoped that a preferential tariff may be arranged, as has been done with South Africa. Such a course would enable the lumber industry of British Columbia to take advantage of the large and growing market which Australia offers.

The standing timber of New Zealand was estimated, in 1914, at approximately 30 billion feet, and the annual consumption at 500 million feet ; the latter is likely to increase rather than decrease. New Zealand will, therefore, have to supply this increase by importation, since she is already endangering her forest capital. The principal soft wood of New Zealand is kauri pine, a wood too light for heavy construction. This is an added reason for the importation of stronger woods, like Douglas fir. The importation of lumber in 1913 was approximately 47,000 M. feet, of which the Pacific Northwest furnished about 20 per cent, or 8,700 M. feet.* Of this amount British Columbia contributed 650 M. feet, or less than 10 per cent.

Hawaii and South Sea Islands—As shown by the table on page 16, the exports of timber to the Hawaiian islands amounted, in 1913, to about 54 million board feet, of which none was furnished by British Columbia. The amount imported is large in proportion to the population of the country, but this is due to the fact that almost no construction timber is found on the islands. The exports to Hawaii will probably not increase greatly, but the country can be expected to maintain its present requirements for many years.

*See 'Demand for Lumber in New Zealand,' *West Coast Lumberman*, February 15, 1916, p. 26.

What has been said of the Hawaiian islands is true also of the South Sea islands. The latter take some 12 million feet at the present time, one million feet of which is furnished by British Columbia.

West Coast of South and Central America—The west coast of South America, Central America and Mexico absorbed, in 1913, about 141 million feet from the Pacific Northwest, of which British Columbia furnished about 5 million feet, or 3·5 per cent. With the Panama canal in full operation and peace conditions established in Mexico, the entire Pacific coast of Mexico, Central America and the South American countries is likely to have an unprecedented commercial development. Such a condition will call for a tremendous amount of construction timber, such as the Pacific Northwest can supply. No other region is more favourably situated to supply the demand. So far as is known, these countries have little, if any, general construction timber and must depend, at least to a very large extent, on outside markets for their supply.

California—As shown by Table 3, California imported, in 1913, from the mills of the Pacific Northwest, over 1,238 million feet of Douglas fir timber, of which only about 1·5 million feet came from British Columbia. California imports heavily, notwithstanding the fact that the state has a stand of timber of about 340 billion feet, with an annual cut of over one billion feet. About half this cut, however, is composed of redwood, a timber that cannot compete with Douglas fir for heavy construction purposes. The remaining half consists chiefly of western yellow pine and sugar pine, which can compete more successfully with Douglas fir, but are somewhat inferior to it for general construction. Furthermore, the water rate from the Pacific Northwest to San Francisco or Los Angeles is probably lower than the rail rate to the same markets from the home forests where these timbers are available for cutting. The California demand for Douglas fir is therefore likely to continue and perhaps to increase. There is no reason why British Columbia cannot obtain a larger share of this trade, especially since nearly all classes of forest products are now admitted to the United States free of duty.

Atlantic Seaboard Markets—In spite of the less favourable geographical position, compared with other exporting forest regions, the Pacific Northwest shipped, in 1913, approximately 76 million feet to countries on the Atlantic seaboard. The following table shows these shipments in detail :

TABLE 4.—CARGO SHIPMENTS FROM THE PACIFIC NORTHWEST COAST TO ATLANTIC SEABOARD MARKETS, 1913

(Feet, board measure.)

Destination of shipment	From British Columbia ports	From United States ports	Total
Africa	14,210,000	8,370,000	22,580,000
Atlantic coast of North America	....	3,470,000	3,470,000
United Kingdom and Europe	7,000,000	38,540,000	45,540,000
East coast of South America	4,430,000	....	4,430,000
Totals	25,640,000	50,380,000	76,020,000

ANDERSON LAKE, IN THE COAST MOUNTAINS

KELOWNA, FROM THE WEST SIDE OF OKANAGAN LAKE. IN THE INTERIOR PLATEAU

A comparison of this table with Table 3, giving the cargo shipments to the Pacific seaboard markets, shows that proportionately British Columbia has a much larger share of the Atlantic seaboard trade. The proportion in the case of shipments to the Atlantic seaboard is two to one in favour of the United States, whereas, in the Pacific seaboard shipments, the proportion in favour of the United States is 29 to 3·5 with California included, and 10 to 3·5 without California.

The figures of Table 4 show that British Columbia had the largest share of the Pacific Northwest trade with Africa. This is attributed mainly to the fact that South Africa and Canada have a preferential tariff arrangement that favours Canadian timber as against that from the United States. If similar arrangements could be made between Canada and other portions of the British Empire, especially with Australia, the lumber trade of British Columbia would undoubtedly derive a very great benefit.

The cargo shipments of the Pacific Northwest to Europe, mainly the United Kingdom, amounted to 45 million feet in 1913. Of this amount British Columbia's share was about seven million feet. The large increase in the shipments to Europe, amounting to about 43 million feet in 1914 and 101 million feet in 1915, was due to the unprecedented demand because of war conditions, and cannot be indicative of the normal demand for this timber in Europe, though the fact that the British Government placed a large order in British Columbia is significant. In the readjustment of the world's trade after the war, it is not at all unlikely that Canadian timber will be in great demand, especially in the United Kingdom, and British Columbia will share in supplying this demand.

In 1913 no cargo shipments were made from British Columbia to the eastern portions of the United States and Canada, and only 3,470 thousand feet from the United States side of the line reached these ports.

The following table, however, gives some idea of the effect of the opening of the Panama canal on the movements of lumber to Atlantic coast ports of North America :

TABLE 5.—SHIPMENTS FROM PACIFIC NORTHWEST TO NORTH AMERICAN ATLANTIC PORTS FOR THE YEARS 1913, 1914 AND 1915*

(Feet, board measure)

Ports from which shipments were made	Years of Shipments			
	1913	1914	1915	Total
British Columbia	....	6,591,609	11,336,462	17,928,071
United States................	3,468,709	27,580,300	74,559,585	105,608,594
Total.................	3,468,709	34,171,909	85,896,047	123,536,665

The foregoing figures show an increase from less than three and one-half million feet in 1913 to 34 million feet in 1914, and to nearly 86 million feet in

* Compiled from statistics in *West Coast Lumberman* for March 15, 1915, p. 15.

1915. This is highly significant of the beneficial effect the opening of the Panama canal has exercised upon the Pacific Northwest. British Columbia has shared in these benefits. Others factors, including the Great War, have undoubtedly entered into this rapid development of cargo shipments from the Pacific Northwest to the eastern seaboard markets of North America. The establishment of normal conditions at the close of the war is likely to increase the trade rather than to decrease it.

Comparison of the Pacific Northwest with the Southern Pine Region of the United States

The southern pine region of the United States is the greatest rival of the Pacific Northwest, not only for export business but for nearly all the territory of the United States and Canada east of the Rocky mountains. Besides supplying the markets east of the Mississippi river almost to the exclusion of Douglas fir, this region furnishes a large proportion of the lumber used on the prairies except in the region immediately adjacent to the Rocky mountains and to the international boundary line.

The main products of the Pacific Northwest and those of the southern pine region are much alike. As these products are competing in the same markets, a comparison of the two regions as regards the supplies of timber, the present cut and the possible cut without endangering the forest capital, will be instructive. The following table will enable such a comparison to be made :

TABLE 6.—COMPARISON OF THE PACIFIC NORTHWEST AND THE SOUTHERN PINE REGION

(In million feet, board measure)

	Southern pine region	Pacific Northwest[1]
Estimate of stand, 1913	760,000[2]	1,550,000[5]
Total cut, 1913	14,893[2]	8,877[6]
Cargo shipments to Pacific seaboard markets other than United States and Canada	......	603[7]
Cargo shipments to Atlantic seaboard markets other than United States and Canada	1,300[3]	72[8]
Consumption in United States and Canada	13,539[4]	8,202[4]
Possible cut without endangering forest capital. (Estimated annual growth of the forest.)	7,680[2]	15,500[9]

[1] Exclusive of Alaska.

[2] Compiled from statistics given in *Bulletin No. 308*, Forest Service, U.S. Dept. of Agriculture, 'Shortleaf Pine : Its Economic Importance and Forest Management,' by Wilbur R. Mattoon, Washington, 1915, pp. 4 and 5. The figure 7,680 million feet given for the possible cut without endangering the forest capital is based on Mattoon's estimate of the growth rate of 1 per cent annually, after allowing for loss by fire, etc. See also pages 91-93, *Report No. 114*, U.S. Department of Agriculture, by W. B. Greeley.

[3] Figures compiled from *West Coast Lumberman*, March 1, 1914.

[4] Figures obtained by subtracting cargo shipments of columns 3 and 4 from total cut.

[5] Estimates of this report compiled from various sources.

[6] Table 2, page 12.

[7] Compiled from Table 3, page 16.

[8] See Table 4, page 20.

[9] Rough estimate based on annual increment of 1 per cent.

The foregoing comparison shows that, in 1913, the Pacific Northwest, with a forest capital nearly twice as great as that of the southern pine region, had an annual cut of about 9 billion feet, as compared with the cut of nearly 15 billion feet for the latter region. This difference is due mainly to the difference in geographical position of the two regions. The southern pine region is situated nearer the centre of the greatest timber-consuming districts in the world and, chiefly because of favourable freight rates, can market its products more cheaply.

The table shows that the actual cut of the southern pine region is already nearly twice as great as the estimated annual increment, while, on the other hand, the Pacific Northwest can double its annual production and still not impair its forest capital. These comparisons are most significant, for they indicate that the day is not far distant when the southern pine region will have exhausted its forest capital or drawn on it so heavily that the annual production will have to be reduced. When that day arrives the principal lumbering centre of North America will be shifted to the Pacific Northwest, just as it has in the past been transferred from the white pine region of the Great Lakes district of the United States and Canada to the southern pine region. Meanwhile, the Pacific Northwest cannot expect to realize fully on its forest capital, unless future development creates an unprecedented demand for lumber in the world's markets aside from North America.

Summary

1. The Pacific Northwest forest is situated so far from the principal timber markets of the world that it has not yet been able to realize fully the value of its immense timber resources.

2. In 1913 the lumber cut from the entire region was 8,877 million feet, of which British Columbia supplied 1,157 million feet, or 13 per cent. This is in contrast with the fact that British Columbia has approximately 366 billion feet of standing timber, or 24 per cent of the stand of the entire Pacific Northwest. Of the Coast Belt forest as a whole, British Columbia has nearly 22·5 per cent, or 230 billion board feet. Considering the forest resources of this province alone, 62·8 per cent of the stand is in the Coast belt, and 37·2 per cent in the Interior. The present sawmill capacity of the province is more than double the actual cut. This is true also of the Pacific Northwest region as a whole.

3. The products of the Pacific Northwest forest supply practically all the timber used locally and furnish a large amount of timber to California and to the prairie regions. In 1913 British Columbia's share of this trade with the prairie regions was nearly 75 per cent of its cut.

4. The forest products of the Pacific Northwest invade the markets of eastern Canada and the eastern seaboard of the United States, notwithstanding the long-distance transportation involved.

5. The Pacific Northwest forest is the only large forest region on the Pacific seaboard that has been developed sufficiently to furnish construction timber for export trade to countries that do not produce sufficient quantities of timber of this class for their own use. While the lumber industry of the

British Columbia portion of the region has not been developed quite so fully as that on the United States side, in proportion to the amount of her forest resources, it is, nevertheless, rapidly approaching the latter.

6. The Pacific Northwest furnishes a large share of the construction timber that is imported by the countries bordering on the Pacific seaboard. In proportion to the cut, British Columbia's share of this trade is less than that furnished by the United States.

7. The Pacific Northwest furnishes, in addition, a small quantity of timber to the countries of the Atlantic seaboard, despite severe competition with the products of the southern pine region of the United States, the white pine region of eastern Canada, and the exporting regions of northern Europe. In proportion to her cut, British Columbia contributes a larger share than the United States. The depletion of the southern pineries will ultimately result in shifting the centre of lumber production from the south to the Pacific Northwest.

8. If the Pacific Northwest could develop the markets for its products, it could nearly double the output without impairing the forest capital, and, in the case of British Columbia, the production could be more than quadrupled, provided reproduction be looked after or, at least, be not prevented.

Relations of the Two Forest Belts

Attention has already been directed to the two forest belts, the Coast belt and the Interior belt—the former on the Pacific seaboard, and hence easily accessible to the cheaper water transportation ; the latter from 200 to 350 miles from tide-water but nearer the rail markets east of the Rocky mountains.

The quality of the timber in the two belts is different. On the Coast, about 30 per cent of the cut can be graded as 'uppers,' while in the Interior probably not more than 5 per cent of the cut would be classed as equal to the 'uppers' of the Coast. The proportion of the 'commons' or the 'low-grade' in the Interior is, therefore, much larger than on the Coast. As the prairie market east of the Rockies demands principally the lower grades, the Interior belt is ideally situated, and has sufficient quantities of timber to furnish the entire amount required. In spite of the higher freight rates, however, the Coast belt ships more timber by rail than does the Interior belt. A certain percentage of this is 'uppers' that the Interior belt cannot supply, but the larger part of it is of the common grade.

That the Coast timber can compete successfully with the Interior timber in the rail markets is due to the cheaper cost of logging and milling on the coast. The cost of living is higher in the Interior, the region is more mountainous, and the yield per acre is much less than on the Coast. Again, the Coast lumbermen can get a higher price for their 'uppers,' and can accordingly afford to deliver the 'commons' at a lower price than can the lumbermen of the Interior. If the Coast lumbermen could get an overseas market for their 'commons,' it would relieve those in the Interior of the severe competition

which now exists in the prairie market. At the present time, the export trade demands chiefly the upper grades, but efforts are being made to find an overseas market for the 'commons,' which, if successful, will solve the problem to the advantage of both the Coast and the Interior lumbermen.*

Relation Between the Two Political Divisions

The natural conditions for lumbering in the Coast belt of British Columbia and in that of Washington and Oregon are very similar. British Columbia, as a whole, possibly has a slight advantage, in that the province has a greater mileage of coast line, which is also more protected, thus affording a greater number of good harbours, and giving it a proportionately higher percentage of timber near tide water. It is true that Washington is well favoured in this respect, but Oregon possesses few good harbours on the open Pacific. The natural advantage that Washington has over Oregon in this respect is reflected in the much higher total output of timber from the former state. But this same natural advantage is rapidly depleting Washington of its easily accessible timber, so that each year finds the available timber farther from tidewater, thus increasing the cost of production. In British Columbia the depletion of the easily accessible timber has not been so extensive as in Washington.

The two units under discussion are separated by an international boundary line. This complicates the political conditions more or less, and thus affects the cost of production and the degree to which forest products can move from one country to another.

First, there are tariff regulations imposed by both Canada and the United States, which provide for import duties on finished lumber. Shingles, and also lumber which has not been further manufactured than planed on one side and one edge, are admitted free by both countries, except that, since 1915, a special war tax of 7½ per cent has been imposed on all lumber entering Canada.

The general policy of British Columbia has been to restrict the export of unmanufactured forest products in order that the milling industry in the province might be built up. The exportation of logs, shingle bolts and other unmanufactured wood cut from Crown lands or recently-granted private lands was prohibited. However, to mitigate the effects of the trade depression due to the war, it was deemed advisable to allow, temporarily, the export of logs cut from all classes of lands. This increased the export of logs from a total of about 59 million feet in 1913 to 65 million feet in 1914, and to nearly 107 million feet in 1916. A large proportion of these exports consists of cedar logs for the shingle mills of Washington.

A factor which militates against the British Columbia operator is the cost of certain classes of food supplies and of logging and milling machinery, which is higher in that province than in the states of Washington and Oregon.

The forest regulations in the two units are somewhat different. In the United States, most of the timber land that is easily accessible is owned out-

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* See page 28 for a discussion of these efforts.

right, both soil and timber, by individuals or corporations. But little of the timber of the National forests is on or near tidewater : the most accessible timber was acquired by private owners before the National forest policy was established. As it is necessary for the lumberman to control enough timber to supply his mills for from 15 to 20 years ahead of his cut, the carrying charges in the form of taxes and interest are heavy.

On the other hand, in British Columbia, the Government has retained the ownership of most of the timber land, but disposes of the right to cut timber under the license and lease system. A moderate annual charge is made by the Government on an area basis, for carrying the timber so held by individuals and corporations, in addition to the stumpage dues payable when the timber is cut. Thus, in general, the greater part of the payment for the timber is not made until after the timber is cut.* This arrangement in a measure reduces the carrying charges and offsets partially at least the higher cost of production in British Columbia. In some respects, the license and lease system is similar to the timber sales policy in effect on the National forests in the United States. However, as previously stated, the amount of National Forest timber cut in the Pacific Northwestern states comprises only a very small percentage of the total cut for the region.

Until recent years the lumbermen of the different political units have made no well-organized effort to extend their export cargo shipments. Generally speaking, the importing countries bordering on the Pacific ocean needed the lumber and sought it in the cheapest markets. As the lumbermen in Washington and Oregon have been better organized than those in British Columbia and, therefore, better able to supply any demands of the export market, they received the bulk of the trade. Also, at the present time they have better control of the tonnage necessary to carry the product. The lumbermen of British Columbia, also, were so busy supplying the rail markets that they did not until recently recognize the necessity of extending their export markets.

The recent depression in the lumber industry and the inroads made by well-organized manufacturers of substitutes for lumber have awakened the lumbermen of the Pacific coast and elsewhere to a realization of their situation. The lumbermen on both sides of the international boundary are now making strenuous efforts to recover lost ground. In British Columbia the Government has undertaken an educational campaign, the results from which are already apparent.†

In spite of the international boundary line between them, the rivalry of the Canadian and United States lumbermen is friendly and becomes keen only in times of depression. One cannot prosper permanently at the expense of the other. The general conditions of the market are beyond the control of either. Efforts of each to meet these conditions will aid the other. Both are striving to meet them.

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*See chapter on 'Government Relations' for the amount of this charge and a description of the system of timber disposal in British Columbia.

†See pp. 28-29 for details of the nature of this campaign.

In the Interior belt, the conditions on both sides of the international boundary are very similar to those on the Coast in nearly every respect, save that the Interior lumbermen are not concerned with overseas shipments except in so far as their markets are affected indirectly.*

Effect of Geographical Position on the Practice of Forestry

At the beginning of this chapter it was asserted that geographical position determines the degree to which forest products can be utilized. Upon the degree to which forest products can be utilized depends the extent to which intensive forestry methods can be practised. Under this term must be included not only adequate provision for the renewal of the forest on cut-over lands, but also the avoidance of waste in exploitation. Both of these are directly dependent upon the economic factors which determine market conditions and thus fix lumber prices. Until timber values, which are dependent chiefly on utilization, offer sufficient remuneration for the production of new crops, the application of an intensive administration is precluded.

In the Pacific Northwest, this condition has not been fully attained, mainly on account of its geographical position relative to the main markets of the world. Were there no forest regions more favourably situated for competition in these markets, the demand for timber from the Pacific Northwest would be greater, timber values would be correspondingly higher, and, other things being equal, the practice of forestry in the region could be improved.

Another economic condition which now operates against proper utilization has been caused by throwing vast quantities of timber on the market, far in advance of any legitimate demand, and thus depressing prices to a minimum. This is due to a former unwise policy of the governments of both Canada and the United States. Before the conservation policy of husbanding the natural resources was developed to its present state, both governments allowed the alienation of a very large proportion of the accessible merchantable timber. In the United States, this took the more objectionable form of allowing the forests, including the land, to be permanently alienated. In British Columbia, comparatively small areas of forest land containing merchantable stands of timber have been so alienated. Over large areas, however, the timber has been alienated under license or lease, the Government retaining the land.

Only a relatively small percentage of this privately held timber can possibly be marketed within the lifetime of the present holders, unless much wider markets are secured. To protect the investments involved, including the purchase price of the timber and the carrying charges, these holders naturally endeavour to realize upon their investments within a reasonable time, and hence there is severe competition among them for the limited markets available. This competition tends to hold stumpage values down to a point very near the

*The Interior forest belt of the United States has made some water shipments of western yellow pine and western white pine. There is reason to believe that the Interior belt of both the political units will contribute increasing amounts to the export markets in the future. This is especially true of the two woods mentioned. The decreasing supply of eastern white pine, for which these woods are substitutes, will increase the demand for the latter.

actual cost and sometimes below that point. This necessarily means low stumpage and low prices for lumber. If the Government held all the timber and released it only as it was needed to supply the markets, this ruthless competition among the local timber-holders would be eliminated and stumpage and lumber prices would rise to a level where reasonable and legitimate profits would be normally possible.

From the foregoing argument, it is to be inferred that many of the features of ideal forest management cannot at present be put into operation because, at the prevailing level of timber values, they would not pay, especially from the private owner's viewpoint.

Closer Utilization Necessary

One of the essentials of better forest methods is closer utilization. The home and nearby markets of the Pacific Northwest cannot absorb more than a relatively small proportion of the lowest grades of lumber. In some instances, the case is aggravated by the efforts of operators to produce the highest possible percentage of 'uppers,' which offers a large margin over the cost of transportation to the more distant markets. Generally speaking, it costs as much to transport lumber worth \$8.00 per thousand feet as it does to transport lumber worth \$20.00 per thousand. Thus the cost of \$8.00 lumber becomes proportionately higher when it reaches a far-distant market. The great markets of the world can usually obtain nearer home sufficient low-grade timber which can be procured at a lower price than the \$8.00 timber from British Columbia plus the freight rate to the far-distant market. The result is that the lowest grade logs are left to rot or burn in the cuttings. A reliable authority estimates that the Coast lumbermen cannot afford to extract No. 3 logs ; and, at the present time, at least 30 per cent of the potential lumber of the tree is not utilized but is left to rot or burn in the woods.

Owing to the absence of a market for this material, much waste in logging and in milling is inevitable. The efforts of the forest administration are being directed toward securing increased markets and thus toward encouraging as close utilization as is financially possible. The establishment of four pulp mills in British Columbia is helping closer utilization, since there is now a market for hemlock and balsam that did not exist formerly. So far as possible, encouragement is being offered to subsidiary industries, such as box factories, etc., to utilize the waste, both in the woods and at the mill.

Campaign to Extend Markets

Based on the assumption that it is an economic waste, and consequently not good forestry, to allow large areas of mature and over-mature forests to remain unutilized if they can be cut at a profit, the forestry organization of the British Columbia Government is making every effort possible to extend the markets for forest products. This campaign has for its principal object the extension of the overseas, the prairie, and the eastern Canadian markets. Besides the distribution of bulletins advertising British Columbia wood, several bulletins designed especially for the use of farmers in the prairie regions have been issued. These contain architectural plans for the various classes of farm buildings, with recommendations for the kinds of lumber that are best adapted for their construction.

This campaign aims to secure and maintain for forest products the legitimate markets to the supplying of which such products are best adapted. Full-page advertisements of British Columbia woods are also carried in the principal local newspapers in the Prairie Provinces. In addition, market extension offices are maintained, one in the Prairie Provinces, one in eastern Canada, and one in the United Kingdom, to promote the interests of the lumber industry of the province.

At various points throughout the world, samples of doors, panels, upper grades and planks of British Columbia woods have been put on exhibition in public places. These are attractively mounted and are accompanied by photographs showing the forests, logging and milling operations, and different classes of construction built from these woods. The Chief Forester of the British Columbia Government was sent by the Canadian Government to the principal lumber markets throughout the world to investigate these markets as an outlet for Canadian forest products. This campaign, probably the first that has ever been carried on by a Governmental forest organization, will undoubtedly show results that will be effective and valuable, not only in helping the lumbermen, but also by indirectly furthering the ends of forestry practice.

In connection with the prospective increase in overseas markets, there is an element of possible danger which should be carefully guarded against. The demand from the foreign lumber markets is restricted almost entirely to the higher grades of material. Good forestry practice demands the utilization of all material from the trees cut, as well as the logging of so-called inferior species. Unless the market for such low-grade lumber can be developed co-ordinately with the demand for the upper grades, it is inevitable that a great deal of waste will result. This waste will appear in at least three forms—trees felled will be but partially utilized, leaving a great amount of timber in the woods to rot on the ground ; large amounts of low-grade material will be destroyed in the woods or mills ; and inferior species will be left wholly or partly uncut.* The local development of subsidiary industries would go far toward eliminating these forms of waste. The box, veneer, distillation and cooperage industries are examples of what should be developed in this connection. There is no doubt that a very much larger amount of low-grade lumber could be disposed of in foreign markets if concerted efforts in this direction were made by the trade. A uniform and efficient system of inspection and grading is essential in this connection. This would definitely fix the grades in the export market, and eliminate the prevailing wasteful practice of under-grading in order to secure trade. The establishment of selling agencies in markets where low-grade lumber is in demand, such as China, would also very materially improve the situation. It must, however, be again emphasized that the prime essential to better forestry practice, including closer utilization, is an increase in the price of lumber, with consequent higher stumpage values. If the consumption at home, and in the nearby rail markets where the low grades can be absorbed, does not keep pace with the consumption in the over-

*See 'Some Public and Economic Aspects of the Lumber Industry,' by W. B. Greeley, *Report No. 114*, U.S. Dept. of Agriculture, pp. 64-66.

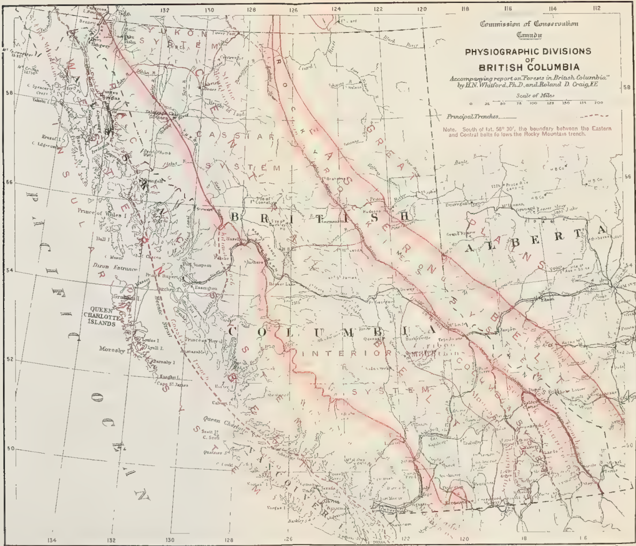
seas markets, where the present demand is chiefly for the upper grades, stumpage values are not likely to increase, although lumber prices may, and improvement in forestry methods generally will be held in check.

On the other hand, it is argued that the needs for the present must be met as well as those of the future, and that better forestry methods must wait until the time is more favourable for their introduction. It is pointed out that over one-half the capital invested in mills and machinery in the province is idle, that mill operators have timber holdings on which they must realize, and that the province depends upon the lumber industry for its prosperity. Moreover, it is maintained that besides the waste of idle capital in saw-mills, etc., the annual waste by rotting of over-mature timber in the forests will compensate in a measure for the necessary waste left after logging because of lack of markets for the low-grade material. In the interests of forest protection, however, it is advisable to have the land logged as clean as possible and the slash burned, which results in the destruction of all the timber which cannot be profitably utilized at the time of cutting.

Waste by Forest Fires

The chief waste in the forest is that caused by fire. The greatest contribution that the forest management of the region has made to forestry has been the progress toward saving the mature forests from fire, and, in particular, the protection from destruction of the great areas of young forest growth and immature timber formerly occupied by a heavy stand of mature timber. It was clearly recognized that any attempt to practise better forestry methods would be futile without a well-organized control of the fire situation. Consequently, the main efforts of the forestry organizations in the region have been directed toward fire protection. The principal features of this campaign have been propaganda, the shaping of legislation, and the perfecting of organizations to prevent and control forest fires.*

*For further discussion of fire protection see Chapter V.



Base map from plate of Map of Dominion of Canada, Dept. of Interior

CHAPTER II

Physiographic Relations

CORDILLERAS OF CANADA

Belts	Systems	Mountains or plateaus	Ranges, groups or plateaus
Eastern	Rockies system	Rocky mountains	Hughes range Brisco range Livingstone range Palliser range, etc. Other ranges and groups
		Mackenzie mountains	Sayunei range Tigorankweine range Other ranges and groups
		Franklin mountains	Un-named ranges and groups
	Arctic system	Richardson mountains	Un-named ranges and groups
	Columbia system	Selkirk mountains	Purcell range McGillivray range Moyie range Slocan group Nelson range Other ranges and groups
		Monashee mountains	Christina range Midway group Other ranges and groups
		Cariboo mountains	Un-named ranges and groups
Central	Interior system	Fraser plateau	Bonaparte plateau Arrowstone plateau Other plateaus, ranges or groups
		Nechako plateau	Ootsa-François plateau Nadina mountain Other plateaus
		Un-named mountains and plateaus	Un-named ranges, groups and plateaus
	Cassiar system	Stikine mountains	Klappan range Ground-hog range Other ranges
		Babine mountains	Un-named ranges and groups
		Un-named mountains	Un-named ranges and groups
	Yukon system	Yukon plateaus	Teslin range Glenlyon range Pelly range Un-named plateaus and ranges
		Un-named mountains and plateaus	Un-named ranges, groups and plateaus

CORDILLERAS OF CANADA—*Continued*

Belt	Systems	Mountains or plateaus	Ranges, groups or plateaus
Western	Pacific system	Cascade mountains	Un-named ranges
		Coast mountains	Tahtsa range Whitesail range Telkwa range Un-named ranges
		Bulkley mountains*	Zymoetz range Seven Sisters group Rocher Déboulé range Hudson Bay group
		Un-named mountains	Un-named ranges and groups
	Insular system	Vancouver Island mountains Queen Charlotte mountains St. Elias mountains (part)	Un-named ranges and groups

Trenches

Rocky Mountain Trench—The great intermontane valley lying immediately to the west of the Rocky mountains.

Purcell Trench—Follows the depression occupied by Kootenay lake, and Duncan and Beaver rivers.

Selkirk Trench—Divides the Selkirk mountains from the Monashee mountains.

Coastal Trench—Between Coast mountains and Insular system.

General Description

British Columbia has been described as a 'sea of mountains.' So extensive are the mountains, and so high above sea level is the average elevation of the bottoms of the valleys, that were the area levelled to a plateau, it has been estimated that it would be not less than 3,500 feet above sea level.

The main structural features of the province have a general northwest and southeast trend, in some instances extending the entire length of the province, and in others for only a portion of its length. A reference to the Physiographic map will show these features.

In the northeast corner of the province is a triangular area east of the Rocky mountains. This area is a northwest extension of the Great plains which lie east of the Rocky mountains. Together with adjacent portions of Alberta, the region is generally known as the Peace River district.

The second physiographic unit comprises the Rocky mountains. From the 49th parallel to its intersection with the 120th meridian, lat. 54° 05′ N., the watershed range forms the boundary between Alberta and British Columbia. From lat. 54° 05′ N., northward, as a result of the northwesterly trend of the Rockies, their eastern slopes are, from approximate lat. 54° 30′ N., wholly within British Columbia.

*The so-called 'Bulkley mountains' are an integral portion of the Coast mountains. No evidence has been adduced or can be adduced that would justify their segregation as a separate unit, and the writer formally protested such action by the Geographic Board of Canada.—James White.

WASTE LAND, AT HEAD OF CHEHALIS RIVER, LOWER FRASER RIVER, COAST MOUNTAINS

ALPINE REGION, AT THE HEAD OF CHEHALIS RIVER, COAST MOUNTAINS

Situated at the western base of the Rocky mountains is a remarkable U-shaped trough, some 900 miles in length, extending from south of the international boundary to Yukon territory. The floor of this valley has, in Canada, an average elevation of approximately 2,400 feet above sea level and an altitudinal range of about 700 feet. The valley is from 2 to 15 miles in width and is flanked on both sides by high mountains for the greater portion of its length. It is drained by several rivers with low passes between them ; in respect to size, the valley is often out of proportion to the streams that drain it. The direction of drainage is determined by fault lines or zones, which mark the boundaries between different rock formations. This great trough has been brought to its present form by long-continued erosion of valley glaciers, powerful enough to ride over the divides between the former heads of the streams and to degrade them nearly to common level. Such valleys are called intermontane, or valley, trenches. This particular valley, called the Rocky Mountain trench, is probably the most remarkable one of its kind in the world.

The Columbia system lies to the west of the Rocky Mountain trench, extending as far north as Fraser river, lat. 53° 45′ N. This system comprises the Cariboo mountains in the north, and the Selkirk and Monashee mountains in the south. Separating the Selkirk and Monashee mountains is the well defined Selkirk trench, which is occupied by the Columbia river and the Arrow lakes.

The Selkirk mountains are dissected by several large structural valleys, the relative physiographic importance of which has not as yet been determined. From a forestry viewpoint, however, the Purcell trench is the most important. This valley is occupied by Kootenay lake and Duncan river, draining towards the south, and Beaver river, flowing north into the Rocky Mountain trench at Beavermouth, where the Canadian Pacific railway enters the latter trench from the west. It is from one to five miles wide.

The next physiographic feature for consideration lies between the Columbia, Cariboo, and Rocky mountains on the east, and the Coast mountains on the west.

This area is divided into three parts, the Interior, the Cassiar and the Yukon systems. To the traveller crossing the province on the Canadian Pacific railway through the deep valley of the Thompson river, the Interior plateau seems mountainous. Generally speaking, however, if the traveller climbs to the top of one of these 'mountains' he will find that there are no sharp peaks, but will find, instead, irregularly rounded or comparatively flat-topped summits, which have a fairly uniform elevation. In the Cassiar system, the uniformity of the elevation found in the Interior system is interrupted by isolated ranges and mountain groups. As the plateaus merge gradually into the mountains that flank them on either side, it is often difficult to draw a line indicating the division between plateau and mountains. As, throughout the western portion of the Skeena system, the plateau is very much broken by small mountain ranges, the boundaries shown on the map are only approximate.

The Coast mountains, comprising another physiographic unit, border on the inland waters of the Pacific ocean from the Fraser river to the head of Lynn canal in Alaska.*

North of Portland canal, the boundary line between British Columbia and the 'pan-handle' of Alaska, runs on, or near, the axis of these mountains, consequently, in this area, only their eastern slopes are within the forested area of the province.

Lying between the Coast mountains and the ranges occurring on Vancouver island and Queen Charlotte islands—known collectively as the Insular system—is a submerged trench which, for the purposes of this discussion, is called the Coastal trench. It extends north to the head of Lynn canal, thus separating the Coast range from Vancouver Island, Queen Charlotte and other mountainous islands of British Columbia and Alaska. It extends south through Puget sound, dividing the Olympic mountains from the Cascades, and continues as a land trench through Washington and Oregon. These mountainous islands are separated from each other and from the Alaskan extensions, as well as from the southern Olympic continuation, by tidal waterways.

With this bird's eye view of the principal features of the topography, the influences of these features on lumbering and forestry may be noted.

Primarily, the mountains have a general parallel trend, alternating with plateaus or mountain trenches, all at right angles to the warm, moisture-laden westerly winds. This arrangement of the main physiographic features is of very great importance, since it controls the factors of climate, temperature and moisture, and thus determines the distribution of the different types of forest. The discussion of this relationship is, however, reserved for the chapter entitled 'Climatic Relations'.

The mountainous character of most of the topography of British Columbia renders a large proportion of the area unfit for agriculture, and a great portion of the province is suitable only for the growing of timber. Thus, of a total land area of 353,416 square miles for the province, 38 per cent (133,500 square miles), is suitable for the production of timber, 57 per cent (200,000 square miles), is incapable of growing merchantable timber, and the remainder, 5 per cent, nearly (19,916 square miles), may be ultimately devoted to agricultural pursuits. As will be seen in another connection, however, considerable areas of absolute timber land may be used also for grazing purposes.

During the glacial period, a continuous ice sheet covered the entire area of the province, with the exception of the highest mountains. On the retreat of this ice sheet, powerful valley glaciers fed by those of the higher mountains, scoured out the then-existing valleys, over-rode divides, and, on their retreat, left the bottoms of the valleys filled with a covering of glacial debris of varying depth, with lakes scattered here and there. The subsequent normal stream erosion lowered the valleys and the lakes, eliminating some of the latter, and leaving the valleys and lakes flanked on either side by benches. The scouring

*Coast mountains is the name applied to these mountains by geologists. Though they are frequently, but erroneously, called the Cascade mountains, the only portion of British Columbia occupied by the Cascades is a relatively small area lying to the east of the Fraser river. (See Physiographic map.)

action of the ice, in lowering and broadening the valleys throughout the province, has resulted in depressing a much larger percentage of the area than would otherwise have been the case. Such action in a mountainous country has been of great importance, for it has greatly increased the area of land suitable for agricultural pursuits. The glacial action in lowering the divides between the headwaters of the different streams, has made such valleys more accessible to each other for transportation purposes. The glacial lakes have played, and will continue to play, an important part in the economic development of the province. In several regions they are still the only means of transportation. The glaciers have in a similar way been of economic service in scouring and lengthening the fiord-like inlets on the Pacific coast, thus increasing the length of the tide-washed coast line.*

The main trenches, with the broad U-shaped valleys throughout the province, are of great strategic value from the standpoint of lumbering. They determine the location of depots for the accumulation of raw forest products for manufacturing purposes. The trenches themselves, or their slopes, and the lower ends of the valleys debouching into them, furnish the greatest supplies of lumber cut at the present time. The relative importance of the trenches varies, of course, according to the kind and amount of timber in and tributary to them, and according to their geographic position with relation to the markets.

Because of the strategic importance of the trenches, it has been thought advisable, wherever practicable, to discuss the topography adjacent to the trenches, in connection with them.

Coastal Trench

The main economic feature of this trench is that it is navigable throughout its length and contains numerous inlets, some of which penetrate far inland. This advantage, combined with the fact that three-fifths of the timber of the province is situated adjacent to it, gives it great importance. With the exception of the timber on the west coasts of Vancouver island and of the Queen Charlotte islands, the natural manufacturing depots for this material are situated at favourable points along the borders of the trench.

In some cases, the inlets or fiords penetrate inland as far as the axis of the Coast and Vancouver mountains, thus increasing the length of the coast line, and bringing the timber bordering them within easy reach of tide-water. The presence of numerous islands in the trench is another feature favourable

* Dr. J. W. Gregory, in *The Nature and Origin of Fiords*, pp. 12, 13 and 317, says: "Many fiords were no doubt once occupied by ice, and were influenced by it; but they were not made by it. Fiords are not limited to formerly glaciated areas, and, even in glaciated countries, their distribution is inconsistent with their glacial formation. . . .

"Moreover, the plan of the fiord systems in each country does not appear to be that which would have developed as the result of glacial erosion. The chief fiord systems in the world have the same essential plan. Each fiord area is long and curved ; fiord channels extend along the coast ; other fiords run inland, and cross-fiords often divide the country into angular blocks.

"The network is not the arrangement that would be found if the fiords had been excavated by glaciers ; for, in that case, the main channels would be radial from the chief centres of snowfall.

"The fiord-valleys [of the British Columbia coast] were in existence before the glacial occupation of parts of the fiord regions ; the slopes have doubtless often been smoothed, the spurs that projected into the valleys have been cut back and the floors deepened by glaciers. The fiord system is, nevertheless, a pre-glacial feature."

to logging operations. Besides increasing the extent of coast line, the sheltered waters behind these islands afford favourable courses for rafting the timber to the manufacturing depot. Generally speaking, the topography bordering the trench is rough.

The rugged Coast mountains flank the trench on the east. They extend for its full length, a distance of 900 miles, from the Fraser river to the head of Lynn canal. These mountains are approximately 125 miles wide in the southern part and 40 miles wide at Lynn canal. Many of the islands are isolated ranges of these mountains, while others represent foothills.

The Coast mountains vary in altitude from 5,000 to 8,000 feet, while some peaks reach an elevation of 9,000 to 10,000 feet. Throughout the range, glaciers and perpetual snow are characteristic features, although, in the southern portion, these occur only at the higher elevations.

Several rivers rise in the Interior plateau and, after traversing the Coast range, debouch into the heads of the inlets. Of these, the most important are the Homathko, Klinaklini, Bellakula, Dean, Skeena, Nass, Stikine and Taku. The Fraser river rises in the Rocky mountains (lat. 52° 50′), completely traverses the Interior plateau, flows round the southern extremity of the Coast mountains, and debouches into the Coastal trench. Its discharge is so large that the silt deposited near its mouth has built up a great delta. The other rivers have formed only small deltas at their mouths. The valleys of these rivers and the inlets that are really continuations of them, were formerly occupied by glaciers, which deepened them and gave them their present U-shape.

Several of the main valleys and many of the smaller valleys are connected by cross glacial valleys. Where the cross valleys are below sea level they are, of course, occupied by tide-water channels that separate the islands from the mainland or from each other. Where the glaciers have not scoured the cross valleys so deeply, they are known as 'through valleys,' and are usually occupied by streams. One of the most prominent of these is the valley that connects Kitimat arm, at the head of Douglas channel, with Nass river. Shorter valleys of this nature are numerous. All such valleys contain heavy stands of timber.

In many places, precipitous mountain slopes extend down to tide-water, and beaches are altogether lacking. Such slopes are bare or support only a few stunted trees. Where the slopes are not so steep they are usually covered with better forest growth, while the more gentle slopes and valleys are densely forested. In favourable places the water is so deep that vessels can discharge their cargoes directly upon the shore.

To sum up, the principal valleys, partly subaqueous, and partly subaerial, extending back through the mountains into the plateau, the innumerable smaller valleys debouching into them, the labyrinth of channels encircling the islands, the numerous 'through valleys' connecting the main valleys ; these are the physiographic features favourable to the economic utilization of the forest products. The one unfavourable feature is the fact that a considerable percentage of the long coast line is rocky and precipitous, thus making operation more difficult for the lumberman.

About three-fifths of the standing timber, or 215 billion feet, is tributary to this trench. Of this amount, approximately 180 billion feet is found at the extreme southern end, or south of the northern end of Vancouver island. At present, this portion of the trench furnishes about 65 per cent of the total lumber cut of the province. The logging operations are scattered mostly along the channels and inlets between Vancouver island and the mainland, and nearly one-half of the mills of the southern end of the trench are adjacent to the city of Vancouver, the principal seaport of the province and the terminus of the Canadian Pacific and Canadian Northern railways.

Rocky Mountain Trench

From a lumbering standpoint, this trench is next in importance to the Coastal trench. As shown by the Physiographic map, it parallels the latter trench throughout the length of the province. If this trench were filled with water, it would have practically all the topographic features of the Coastal trench. As the bottom of the trench is dry, save for the rivers and lakes that drain it, a larger percentage of its area is favourable to forest growth. Portions of nearly all the larger rivers in the province drain portions of this topographic unit. Beginning at the south, its drainage units, in British Columbia, are, successively, the Kootenay, Columbia, Canoe, Fraser, Parsnip, Finlay and Kachika rivers.

All the valleys of the western slope of the Rocky mountains drain into this trench, and, with few exceptions, the timber in these valleys must reach some portion of the trench before it can be placed on the market.

The Rocky mountains constitute a comparatively narrow belt of high, rugged topography, the higher altitudes of which contain many glaciers. Upwards of 100 peaks have an altitude of more than 10,000 feet, and one, mount Robson, rises to an elevation of 13,068 feet above sea level. From the southern boundary of the province to latitude 52° 50′ N., the western slope is drained by the Columbia river and its branches, the Kootenay and Canoe rivers ; between lats. 52° 50′ and 54° 30′ N., the waters of the western slope find their way into the Fraser river. North of 54° 30′ N., the Peace river, at about latitude 56° N., and the Liard river, latitude 59° 30′ N., break entirely through the mountains and drain the western as well as the eastern slopes.

Many valleys have cut deeply into the Rockies. South of the Peace river, these valleys or their branches are roughly parallel to the axis of the Rocky mountains ; just before they debouch into the rivers of the Rocky Mountain trench, however, they assume a trend more or less at right angles to the axis. The valleys are bounded by a number of mountain ranges, which have the same general trend as the rivers. They have been profoundly glaciated into a broad, U-shaped form, flanked on both sides by terraces. In some instances, these secondary valleys occupy lines of structural weakness and, like those of the main trench, can be designated as trenches of the second rank. Beginning from the south and proceeding north, the largest of these secondary valleys or trenches are drained by the following rivers :—Flathead, Elk, Bull, upper Kootenay, Kicking Horse, Blaeberry, Bush, Wood, upper Fraser, Torpy (Clearwater), McGregor (North fork of Fraser), and tributaries of the Parsnip.

The waters of a portion of the Selkirk and Columbia mountains, of the northeast slope of the Cariboo mountains, and of the east slope of the Omineca range and Cassiar mountains find their way into the streams of the Rocky Mountain trench. The streams of the east slopes of these mountains are not usually so large, nor do they assume so pronouncedly the north-and-south trend of the axis of the mountains they drain, as do those of the Rockies. From south to north the principal of these streams are : St. Mary river, Skookumchuck creek, Findlay creek, Horsethief creek, Spillimacheen river, Beaver river, Raush river, Doré river, Goat river, Crooked river, Nation river, Manson creek, Omineca river, Ingenika river, upper Finlay river and Turnagain river.

North of the north end of the Cariboo mountains, the Rocky Mountain trench is bordered on the west by a portion of the Interior plateau. Along a portion of the Parsnip river, the non-mountainous area of the Skeena plateau borders this trench. North of this to the Yukon boundary, however, the Cassiar mountains flank the trench on the west.

The main centre of lumbering activity in the Rocky Mountain trench is in the southern portion, where the Crowsnest line of the Canadian Pacific railway crosses it. This railway crosses the Rocky mountains through the Crowsnest pass, descends the Elk valley and emerges into the trench at Elko. Although there are several mills in the Rocky mountains along this railway, the great majority are in the trench itself. In fact, next to the lumber centre at the southern end of the Coastal trench, this is the most important lumbering centre in the province. It has had the advantage of easily accessible timber situated mostly in the trench itself, and thus easily logged. Short branches of the Canadian Pacific system tap a portion of the country to the south and a short distance up the St. Mary river and have thus brought the timber tributary to it within easy reach. A branch of the Great Northern railway extends from Fernie down the Elk and Kootenay rivers, to the international boundary and beyond, thus bringing the timber of the extreme southern portion of the trench within comparatively easy reach.

The recently completed Kootenay Central branch lies wholly within the Rocky Mountain trench and connects the Crowsnest line of the Canadian Pacific with the main line at Golden. This makes more accessible the considerable quantities of timber along its route and in the mountains on either side, especially the timber in the upper Kootenay river above the point where this river debouches into the trench. (See Physiographic map.)

The main line of the Canadian Pacific railway crosses the continental divide by the Kicking Horse pass, parallels the river of the same name to its mouth, debouching into the Rocky Mountain trench at Golden, and follows this trench north to its junction with the Purcell trench. From this point it follows the Purcell trench for a short distance and then crosses the Selkirk mountains on its way to the coast. Before the construction of the Crowsnest line the lumber centre for the Rocky Mountain trench was at Golden. This centre obtains its timber mostly from the forests in the trench and in the tributaries of the Columbia river to the south, especially those that drain the eastern slope of

the Selkirk mountains. Golden is still a fairly important lumber centre, though the supply of timber tributary to it has been much reduced by fires and logging operations, especially the former.

The southern Rocky Mountain trench, being in close proximity to the prairie region just east of the Rocky mountains, has been, and will continue to be, an important factor in furnishing the lumber supplies for that region. For Winnipeg points, this portion of the trench has an average freight rate of 33 cents per hundredweight, as compared with a rate from the coast of 40 cents. To near-by points in Alberta the average rate is 16 cents, as compared with the 40 cent rate from the coast.

While the timber resources of the southern Rocky Mountain trench and its tributary second rank trenches and valleys have been badly damaged by fire and reduced in amount by the operations of the lumbermen, they are still adequate to supply an annual cut even larger than the present production. Although great inroads have been made on the easily accessible timber in the trench, there still remain considerable quantities that can be utilized at a slightly greater cost of logging. Most of the streams in the mountain valleys are driveable or can be made so, thus rendering their stands of timber readily accessible.

The central portion of the Rocky Mountain trench and its tributaries, extending from the northern boundary of the Railway Belt to near the mouth of Parsnip river, contains a considerable amount of timber that has been lumbered but little, and that has not suffered so great damage by fire as the portion farther south. The timber of the portion of the trench occupied by the Fraser river has recently been rendered accessible by the opening of the Grand Trunk Pacific railway. This line crosses the continental divide by the Yellowhead pass, enters the Rocky Mountain trench at Tête Jaune, and parallels the Fraser river to its junction with McGregor river (North fork of Fraser), where the Fraser enters the northern portion of the Interior plateau on its way to the Pacific. The timber in the southern portion of this stretch, including that of the Yellowhead pass, has been badly burned, but the northern portion, though damaged in places by fire, is still relatively intact. This belt of timber is, to-day, the most accessible stand in the interior of British Columbia, and, in the near future, a new centre of the lumber industry is likely to develop in this district. Its natural market is the agricultural country of central Alberta, with Edmonton as a centre.

The timber in the Rocky Mountain trench between the Grand Trunk Pacific and Canadian Pacific railways is not so accessible. The present outlet is determined by the direction of the stream-flow. The timber in the Canoe river and in the Columbia river north of the Railway Belt can be driven to the big bend of the Columbia, and thence down the Columbia, in the Selkirk trench, to Revelstoke or Upper Arrow lake, to be milled.

The proposed extension of the Pacific Great Eastern railway, from Prince George through Pine pass and into the Peace River district of British Columbia and Alberta, would render accessible that portion of the timber of the Rocky mountain trench which is in the drainage basin of the Parsnip river and its

tributaries. The natural market for this timber will be the newly-opened country of the Peace River district, in northern Alberta.

The timber of the Rocky Mountain trench and of its tributaries north of Peace river has been practically destroyed by fire. The few patches that remain are of no present value for lumbering, with the exception of the very small quantities used by placer mines in certain sections. As shown by the map, a considerable portion of the area, if properly protected from fire, is capable of producing timber and can be considered as an important source of timber supplies in the far-distant future.

Selkirk Trench

The physiographic unit described as the Selkirk trench is perhaps third in importance from a lumbering and forestry viewpoint. This valley is drained by a portion of the Columbia river and has a length, in British Columbia, of 225 miles. Midway in its course it is occupied by the Arrow lakes, which are about 92 miles in length. Flanked on the east by the Selkirk mountains and on the west by the Monashee mountains, it receives the drainage of the west and east slopes, respectively, of these ranges. The Selkirks, while somewhat lower in average elevation than the Rocky mountains, are, nevertheless, high and rugged and contain some 53 known peaks which reach an altitude of 10,000 feet and over; of these, five are more than 11,000 feet high. A considerable area of the higher altitudes is covered with glaciers. From trench to trench, the Selkirk mountains have an average width of some 75 miles. They are divided longitudinally by the Purcell trench, and the western portion is further divided into several distinct groups or ranges by cross trenches connecting the Selkirk and Purcell trenches. Of these, one extends from the northeast arm of Upper Arrow lake to the northern end of Kootenay lake and thus connects the Selkirk and Purcell trenches. This cross trench is drained by two streams and a lake, and may for convenience be called the Lardeau trench, from the principal river which drains it.

Another secondary trench connects Kootenay lake, through the valley of the West arm of this lake and the Kootenay river, with the Columbia river. This may be called the Nelson trench, from the principal town situated in it.

The third cross trench extends from the town of Nakusp, near the lower end of Upper Arrow lake, to the upper end of Slocan lake. This portion of the trench has a semicircular trend, first east, then southeast. From the upper end of Slocan lake the trench extends south and meets the Nelson trench not far above its junction with the Selkirk trench. The whole is known as the Slocan trench, after the lake and river that drain most of its course.

Besides these secondary trenches there are several important valleys. South of the Nelson trench, and heading just south of the town of Nelson, is the Salmon river. This stream flows south and empties into the Pend d'Oreille river at a point near the international boundary. Emptying into a bay at the north end of Upper Arrow lake is the Incomappleux (Fish) river. Rising near Rogers pass and flowing west is the Illecillewaet river, which joins the

Photos by F. C. Swannell, B.C.L.S.

DOUGLAS FIR, NORTH OF STUART LAKE, STUART RIVER
INTERIOR PLATEAU

DESTRUCTION BY FIRE OF SPRUCE, NEAR NATION LAKE,
PEACE RIVER WATERSHED

Columbia at Revelstoke. Many smaller streams on the west slope of the Selkirks are tributary to the main trench, and to the secondary trenches and valleys. As the axis of the Monashee mountains lies close to the Selkirk trench, the streams that drain the eastern slope of these mountains are small ; only one of them, the Jordan, is sufficiently large to be called a river.

The Selkirk trench, as a whole, is well supplied with transportation lines. The main line of the Canadian Pacific railway ascends the east slope of the Selkirks, crosses the divide at Rogers pass and descends the valley of the Illecillewaet, crossing the Selkirk trench at Revelstoke. For portions of the year, water transportation is available to Laporte, a point on the Columbia river about forty miles north of Revelstoke. Combined rail and water transportation is available along the trench from Revelstoke south to Trail, near the international boundary. The Crowsnest line of the Canadian Pacific continues from the Rocky Mountain trench across the Selkirk mountains to Kootenay lake. Thence, combined water and rail transportation is available through the Nelson trench to the Selkirk trench. This road continues across the Monashee mountains and the Interior plateau to the coast.

A branch transportation line, both rail and water, traverses the full length of the Slocan trench, and a part of the length of the Lardeau trench. A short rail route connects Slocan lake with Kootenay lake. A rail route starting at Nelson crosses the pass at the head of Salmon river, follows this river for about half its course, and then crosses to the Selkirk trench, which it reaches at a point a few miles north of the international boundary. From here it parallels the Columbia and Spokane rivers, ultimately reaching Spokane, Washington.

The principal market for the timber manufactured in and near the Selkirk trench is the same as for that produced in the Rocky Mountain trench, namely, the prairie region east of the Rockies. The average freight rate from points in the Selkirk trench to the nearest lumber centre of southern Alberta is about 20 cents per hundredweight, or only 4 cents higher than the rate from points in the Rocky Mountain trench. The largest mills are situated at the head of Upper Arrow lake. Although there are smaller mills in other parts of the trench, and along the transportation routes in the secondary trenches and valleys, the head of Upper Arrow lake is likely to remain an important centre. It is a favourable point at which to assemble timber from the heavily forested section of the Selkirk trench to the north ; probably, also it will draw on the timber supplies of that portion of the Rocky Mountain trench which is occupied by Canoe river and by the Columbia river north of the Railway Belt.

Purcell Trench

This trench contains the Beaver and Duncan rivers, Kootenay lake and a short section of Kootenay river. Beaver river flows north from the southern boundary of the Railway Belt to the north end of the trench, emptying into the Columbia river at Beavermouth. Duncan river rises in the same pass as the Beaver and flows south, expanding into the small Duncan lake, and then empties into the northern extremity of Kootenay lake. The waters of Kootenay lake find their outlet through its West arm, which, in conjunction with

a short section of Kootenay river, drains the Nelson trench. The southern end of the Purcell trench is drained by another section of Kootenay river, which enters the southern extremity of Kootenay lake a few miles from the international boundary.

As previously stated the Purcell trench is connected with the Selkirk trench by two lateral branches, the Nelson and Lardeau trenches. The streams which drain into the Purcell trench are short. Of these, the largest are the Yahk, Moyie, Goat and Lardeau rivers. The first two have only their headwaters in British Columbia. They cross the international boundary and debouch into the Purcell trench south of this line. These, together with Goat river, drain the southeastern portion of the Selkirks.

The Selkirks, between the Rocky Mountain and Purcell trenches, have an average width of about 40 miles. The southeastern portion of these mountains contains at least ten peaks that reach an altitude of 10,000 feet; of these, three are more than 11,000 feet in altitude.

For several reasons the lumber industry of the Purcell trench is not so extensive as that of the other main trenches. The area draining into the trench is smaller, and for the greater portion of the length of the trench the slopes are steep. The short streams which enter the trench usually do so by narrow cañons or falls, behind which the hanging valleys broaden out and carry considerable quantities of timber. The timber in these valleys is not easily accessible because of the expense of making the streams driveable. The greatest amount of easily accessible timber is that tributary to the Duncan, Lardeau, Goat and Moyie rivers.

The saw-milling centres are near the north and south ends of Kootenay lake, and along the line of the Canadian Pacific railway, which crosses the Purcell section of the Selkirks, traversing the valleys of Moyie and Goat rivers. The timber has an outlet to the prairie market over this line of railway. There are also two railway lines which extend from the Canadian Pacific railway southward to Spokane. The railway tariff on timber from points in the Purcell trench to the nearest lumber centres of Alberta is about 20 cents per hundredweight and 33 cents to Winnipeg, or the same as that from Selkirk Trench points. Moyie River points have a slightly lower rate than this, corresponding more nearly with rates from points in the Rocky Mountain trench.

West Slope of the Monashee and Cariboo Mountains

This physiographic unit ranks fourth in lumber production, and is likely to surpass the Selkirk trench in this respect.

Generally speaking, the axis of the Monashee-Cariboo mountains is well toward the trenches bordering them on the east and northeast; for this reason, the western slopes of these ranges are longer than the eastern slopes. The Monashee and Cariboo mountains, though not so high as the Selkirk and Rocky mountains, are nevertheless alpine and rugged. They contain no peaks of more than 10,000 feet in altitude, but there are several with an elevation of between 8,000 and 9,000 feet above sea level. Glaciers are present in the Cariboo ranges and in the northern half of the Monashee ranges. The western

slopes grade from the axis of the mountains into a rough plateau, and gradually merge into the Interior plateau that lies to the west. All the streams of the west slope pass through the ill-defined western limit of the mountains into the plateau country before they reach the streams to which they are tributary.

The valleys of these main drainage lines, like those of other portions of British Columbia, have been deepened and broadened by glacial action into the characteristic U-shaped form ; their bottoms are terraced by the erosive action of the rivers on the glacial debris deposited in them. Many of them broaden out into glacial lakes, in some portion of their course. Nearly all have a north or south trend while several bend abruptly to the east or west, either before or after they leave the mountains.

Depending on the principal drainage lines, there are five centres, or groups of centres, around which milling and logging operations are, or can be, carried on. The most southerly of these is the Kettle River centre, known as the Boundary country. This centre utilizes the timber situated mainly on the Granby river (North fork Kettle river) and around Christina lake. This is not an important centre since the tributary timber to it has been much depleted by fire. It has east and west outlets for its timber over the Canadian Pacific and Kettle Valley railways, and to the south into the United States over a branch of the Great Northern.

The area in and near Shuswap lake forms the most important centre for milling purposes in the physiographic unit under discussion. Draining into the lake from the north are Seymour and Adams rivers; from the east, Eagle river ; and from the south, Shuswap river. The outlet for the timber is the main line of the Canadian Pacific railway. This road crosses the Monashee mountains, descends the valley of Eagle river, follows the south shore of Shuswap lake, and descends the valley of the South Thompson and Thompson rivers. A branch line from Sicamous connects the main line with Okanagan lake to the south. There are saw-mills at various points on Shuswap lake, also on Eagle river, and at Enderby on the Okanagan branch of the Canadian Pacific railway. Freight rates to the nearest lumber market centres in Alberta and to Winnipeg are only slightly higher than those from points in the Selkirk trench.

The timber in the upper reaches of the North Thompson valley has now been rendered more accessible by the completion of the Canadian Northern railway. This line parallels the Grand Trunk Pacific railway through Yellowhead pass, turns abruptly to the south, traverses the portion of the Rocky Mountain trench occupied by McLennan river and Camp creek—a branch of Canoe river—then crosses the Albreda summit to Albreda river, and continues down this river and the North Thompson to the mouth of the latter at Kamloops. One of the main branches of the North Thompson, the Clearwater river, rises in a series of lakes on the southeast slope of the Cariboo range. The timber in the Clearwater basin will find a natural outlet down the Clearwater to the North Thompson. Another possible outlet for timber in the upper portion of this basin is across the low divide to Quesnel lake.

The Quesnel river rises in the southwest slopes of the Cariboo mountains. The lake area of this region is very large, including Quesnel lake and several smaller lakes. The timber in this section can be driven down Quesnel river to the town of Quesnel on Fraser river, to the Pacific Great Eastern railway, now under construction. A railway connecting Quesnel lake with some point on the Pacific Great Eastern would render the timber of this region more accessible.

The headwaters of Willow and Bowron rivers are fairly heavily timbered. They have their sources in low passes which connect with the Quesnel drainage. These rivers flow north to the Fraser. In the absence of railway connection, the timber must be driven down these streams ; in their present condition they are not easily driveable, but, with some improvements, could be made so.

Interior Plateau

The region lying between the Coast and Cascade mountains on the west and the Monashee, Cariboo and Rocky mountains on the east, is divided into three regions, the Interior system, the Cassiar system, and the Yukon system.

The Interior system is approximately 500 miles long and varies from 140 miles to 170 miles in width. The nature of its relief can be best indicated by a description of its physiographic development. In early Tertiary times the area was mountainous and rugged, but later was reduced by erosion to a less rugged condition ; then came the eruption of the extensive lava flows that covered the whole area to a greater or less extent. A second period of erosion reduced the area to the stage of late maturity. It was then uplifted, and the main river valleys were cut deeply into the region by erosion. The country was subsequently glaciated by the continental ice sheet, with local valley glaciers extending along the main valleys. These glaciers modified the existing drainage, and, on their retreat, left glacial deposits. Later, the rivers, cutting through these glacial deposits, gave rise to a series of terraces upon the valley floors.

The present condition shows two types of topography ; first, the *main valleys*, in which the action of the valley ice greatly affected the topography, and, secondly, the *uplands*, on which the retreat of the more sluggish continental ice sheet left a thin layer of glacial drift, but did not modify the old drainage system so profoundly.

The main valleys cover approximately one-third of the area of the plateau. Of these, the principal ones are portions of the Fraser and its tributaries, especially the Nechako, the Blackwater, the Chilcotin, the Thompson, the South Thompson, the North Thompson, and the Nicola. At the south end are the Okanagan, the Similkameen and Kettle rivers, which flow into the Columbia. In the extreme northwest, the plateau is drained by the headwaters of Babine river, a branch of the Skeena. In the northeast are the headwaters of the Nation and Pack rivers, whose waters find their way through Peace river into the Mackenzie.

The valleys occupied by these rivers and their main tributaries are U-shaped, becoming more and more V-shaped as they approach their junction

with the upland topography. At this junction, they usually pass through narrow cañons, above which, on the uplands, they assume a very much flattened V-shape in cross section.

In the southern portion, the uplands are from 4,000 to 6,000 feet above sea level. Toward the north, they decrease to a general level, of from 3,000 to 3,500 feet. The bottoms of the main valleys are from a few hundred feet to 4,000 feet below the uplands, and, in places, rugged hills rise above the uplands. The slopes of the main valleys are much steeper than the valleys of the uplands. The latter are shallow, and small lakes and swamps are everywhere present. Larger lakes lie in the bottom of some of the main valleys. The most important of these are Okanagan and Kamloops lakes at the south, and Babine, Tacla, Stuart, François, Ootsa and Eutsuk lakes at the north.

The plateau is timbered, with the exception of the larger main valleys in the southern portion and the drier portions of the uplands. However, for the most part, this timber is, at present, being utilized only for local use. This is due to several causes. The semi-arid character of the climate prevents the production of timber of the best quality ; moreover, the area has been so badly burned that the present stand is mostly second growth. Again, the fact that it is bordered on both sides by more favoured climatic belts, that are heavily forested, militates against the present utilization of its timber resources, except for local use. In spite of these conditions, however, favoured districts that have escaped severe damage by fire contain quantities of merchantable timber. On the other hand, there are numerous mills situated mainly in the settled valleys of the southern portion of the region. Most of these are small, but several are able to ship timber to outside markets.

The valleys of the Interior plateau are well supplied with transportation facilities. At the south is the Kettle Valley railway, a subsidiary of the Canadian Pacific, which crosses the plateau from Midway on the east and connects with the main line of the Canadian Pacific, at Hope and at Spence Bridge. The main line of the Canadian Pacific railway crosses the plateau from Shuswap lake along the valley of the South Thompson and Thompson to Lytton, where it reaches the Coast range.

From Lytton to Kamloops, the Canadian Northern parallels the Canadian Pacific and then traverses the North Thompson valley for its entire length. At Sicamous, a combined rail-and-water transportation line connects Okanagan Lake points with the main line of the Canadian Pacific railway. A projected branch of the Canadian Northern will connect these points with the main line at Kamloops.

The Grand Trunk Pacific railway enters the plateau from the Rocky Mountain trench, follows Fraser river to Prince George, ascends the Nechako and one of its branches, and descends the Bulkley to the Skeena, following the latter through the Coast range.

The uncompleted Pacific Great Eastern railway crosses the plateau from north to south from Prince George to Lillooet, where it leaves the plateau to reach tide-water through the Coast range. All these lines, except a portion of the Pacific Great Eastern, follow the main valleys. The latter railway

traverses the uplands for a short distance, but, for most of its course, it follows the Fraser river and its tributary valleys.

The headwaters of the Skeena river rise in the west slopes of the Omineca mountains, and those of the Stikine in the west slopes of the Cassiar mountains. At the extreme northern end, the Dease river drains a portion of the western slopes of the Cassiar mountains. From a commercial viewpoint, the timber on the headwaters of these rivers is entirely inaccessible at present.

Cassiar System

This division lies north of the Interior plateau (see Physiographic map). Though, in part, an extension of the Interior plateau, its continuity is interrupted by several important mountain ranges. Some of these ranges toward the southwest portion of the unit are, possibly, outliers of the Coast mountains, and might be considered a part of the Coast Mountains physiographic unit. The Cassiar system is drained on the west by the upper portions of the Skeena, Nass, and Stikine rivers, which traverse the Coast mountains and empty into the Pacific.

From a lumbering standpoint, this region, as a whole, is, at present, commercially unimportant. The southwest portion is, however, likely to become commercially important, especially portions of the Nass and Skeena drainage areas. Here, the valleys are wider and much lower and, in places, carry considerable quantities of timber. A number of small mills already exist along the line of the Grand Trunk Pacific railway, which traverses the southern part of the region. The timber in the Nass valley is adequate to supply the local needs and to leave a large surplus for outside purposes, should it ever prove profitable to log it. Its outlet would be *via* the river to points on the Coastal trench.

Yukon System

The extreme northern portion of British Columbia, above approximately the fifty-ninth parallel of latitude, is considered to be the southern portion of the Yukon system. Its relief is not so rough as the mountainous region to the south. The elevation varies from 3,000 feet to 5,000 feet above sea level. The western portion of this unit in British Columbia is drained by the Taku river, and by the head-waters of the Lewes river ; the eastern portion is drained by the Frances and Dease rivers. The latter rises on the east slope of the Cassiar mountains, and flows round the low northern end of these mountains. Its confluence with the Frances to form the Liard river is near the Rocky Mountain trench.

This region, because of its high latitude and comparatively high altitude, cannot be considered capable of ever producing timber for other than local use. Many of the valleys, however, are forested, and, were it not for devastation by fire, would have many times their present quantity of timber. The timber is small in amount and of poor quality, but, since it supplies the local needs of the mining interests, which constitute the chief industry of the region, it is of great relative importance.

Great Plains

This region, known as the Peace River district, consists of the eastern slopes of the Rocky mountains and the adjacent plains, and is drained principally by the Peace and by the Fort Nelson branch of the Liard. A relatively low range of mountains, with an average altitude of about 3,500 feet above sea level, forms the divide between these two drainage basins. The Peace River drainage area comprises the southern portion of the Peace River district. The Plains portion of this region has an altitude of approximately 2,500 feet, with valleys at a lower altitude, the minimum being the Peace river at the British Columbia and Alberta boundary, 1,300 feet. Because of the agricultural possibilities of a portion of the region, its forest resources will fulfil an important function in supplying local needs.

A considerable portion of the area is capable of forest production, and some of the timber that has escaped the ravages of fire will be rendered accessible by the projected extension of the Pacific Great Eastern railway, from Prince George to the Peace River valley. Many of the forested valleys contain streams that are driveable or can be made so with some improvements, thus rendering the timber along them accessible for exploitation.

The northern portion of the east slope of the Rockies and that portion of the Great plains within British Columbia drain mainly to the north. This region has an altitude of about 2,000 feet and contains narrow belts of forest along some of the streams, heavy enough to furnish considerable quantities of saw timber. The comparatively flat uplands between the streams are poorly drained areas, which alternate with low ridges. These ridges are capable of growing timber of merchantable size, but practically none exists because of the ravages of fire. The swamps contain scrub timber that seldom reaches merchantable size. The quantities of timber are sufficient to supply local needs, should the region ever realize the agricultural possibilities that explorers predict. The lower eastern slopes of the Rocky mountains are capable of bearing timber, but have been badly burned.

CHAPTER III

Climatic and Soil Relations

GENERAL CLIMATIC CONDITIONS

As has been stated in the preceding chapter, the comparatively mild climate of British Columbia is due in the main to its position relative to the Japan and Arctic ocean currents. Latitude for latitude this position gives it a climate which, in general, is similar to that of western Europe rather than to that of eastern Canada. However, comparison with the climate of western Europe is somewhat modified by the presence in British Columbia of a series of parallel high mountain barriers alternating with areas of lesser altitude, all situated at right angles to the general direction of the westerly, warm, moisture-bearing winds. Instead of the fairly uniform climate that prevails over the comparatively non-mountainous region of western Europe, there exist in British Columbia a series of longitudinal belts of climate which, when contrasted with each other, show great differences, especially in precipitation.

There are five primary belts of this character. Three belts extend the entire length of the province, and two extend only a part of its length. From west to east, these belts are, for the purposes of this report, named as follows :

Coastal Belt
Dry Belt
Interior Wet Belt
Rocky Mountain Belt
Great Plains Belt.

While these belts correspond in general to the primary physiographic features of the province (see Physiographic map), there are some variations which will be noted later.

Coastal Belt

This belt comprises all the region west of the axis of the Coast mountains. Its main characteristics are high precipitation and comparatively mild temperature. The difference between the average mean temperature of winter and of summer is not great. The westerly winds of the Pacific, crossing the colder Arctic current and striking the cooler higher slopes of the coastal mountain barriers, are forced to liberate most of their moisture, thus giving an annual precipitation to the Coastal belt that varies from about 40 inches to over 120 inches. This variation depends on the position of minor mountain ranges. Thus, that portion of the Coastal trench lying on the leeward side of the mountains of Vancouver island receives less rainfall than either the west coast of the island

Plate VI

Photo. by Shields Lumber Co.

DOUGLAS FIR, IN FRASER VALLEY, COAST MOUNTAINS

SITKA SPRUCE AND COTTONWOOD, IN SKEENA VALLEY, COAST MOUNTAINS

or the northern portion of the Coastal trench. The extreme southern portion of Vancouver island has an annual precipitation of only 30 to 40 inches. This seems due to the fact that it lies behind the higher Olympic mountains of the state of Washington, and to the absence of high mountains in the vicinity. The area to which this lower rainfall applies is, however, small.

At the meteorological stations near sea-level, the Coastal belt shows a mean annual temperature varying from 44° to 49°, with a summer mean of 55° to 61°, and a winter mean of 30° to 38°.* The lower temperatures are to the north and the higher temperatures to the south.

As these figures represent only the stations of lower altitudes, they cannot be taken as indicative of the climate of the belt as a whole. Naturally, the temperatures of the higher altitudes are lower. At sea level, the precipitation is mostly in the form of rain. Thus Vancouver (lat. 49° 17′ N.), with an average annual precipitation of 61 inches, has a snowfall of only 25 inches, equivalent to two and one-half inches of rain, or four per cent of the total. At Port Simpson (lat. 54° 34′ N.) the average annual precipitation is 92 inches, a little over four per cent of which is in the form of snow. On the other hand, stations at sea level, situated at or toward the heads of inlets, show a larger percentage of the precipitation in the form of snow. Thus, Nass harbour, in about the same latitude as Port Simpson, has a precipitation of 80 inches, 14 per cent of which is in the form of snow. Obviously, at higher altitudes on the west slopes of the mountains, the proportion of the precipitation in the form of snow is much greater ; indeed, so heavy is the snow-fall that the melting of it in the summer months is insufficient to keep pace with the winter fall, hence large areas at comparatively low altitudes are covered with perpetual snow and glaciers. Hence the low absolute timber line of the west slopes of the Coast mountains. Thus, for southern British Columbia, this absolute timber line is about 4,500 to 5,000 feet altitude, while in the southern Rocky mountains it is about 7,500 feet altitude.

The average precipitation for all the meteorological stations on the coast is 81 inches. Of this amount, 70 per cent falls during the autumn and winter months, and 30 per cent during the spring and summer.

The climate is favourable to the luxuriant development of coniferous forests. Generally speaking, the stands of timber are much heavier in the southern portion of the Coastal belt than in the northern or in portions of the west coast of Vancouver island. While this is attributed to the lower temperatures of the north, it is possible that another factor must be considered, namely, the relatively small amount of light. The rainfall in the northern region is much heavier than that of the south. Thus, the average rainfall (including portions of the west coast of Vancouver island) is 109 inches, while that of the southern region is 59 inches. The heavier the rainfall, the greater the number of cloudy days. There is accordingly less light, and light is an indirect factor to rapid growth.

*The climatic data of this paper have been compiled, in large part, from *The Temperature and Precipitation of British Columbia, 1915*, by A. J. Conner, of the Meterological Serevie of Canada.

Dry Belt

As one travels from the coast, through any one of the numerous passes of the Coast mountains, it will be noted that, after passing the water-parting, one finds a gradual diminution in the luxuriance of the forest vegetation, this diminution continuing to near the eastern base of the Coast mountains, where relatively arid conditions exist. This semi-arid condition continues to the western base of the interior mountain ranges that border the Interior plateau on the east. This section is known as the 'Dry belt' or semi-arid region. Generally speaking, it corresponds to the Interior, Cassiar and Yukon systems. (See Physiographic map.)

Contrasted with the Coastal belt, this region is characterized by a much lower precipitation and greater extremes in temperature. As a rule, the precipitation does not exceed 20 inches, and, in a few places, at the lowest altitudes, the annual average is less than 10 inches. The driest part of the region is found in the valleys of the southern portion, below latitude 51°. Here, the precipitation does not usually exceed 15 inches. Short records show that the few recording stations on the uplands have a greater precipitation than the nearest valley stations. From this, it may be inferred that the uplands have, in general, a higher rainfall than the valleys.

The precipitation in portions of the Cassiar system is greater than that of the Interior and Yukon plateaus. This is attributable, in part, to its mountainous topography, and, in part, to the fact that the mountain barriers between the plateau and the coast are lower and more deeply penetrated by ocean inlets. This allows a larger proportion of the heavily-laden atmospheric moisture to escape being precipitated on the west slopes of the Coast mountains, and leaves more to be released when the moist winds strike the west slopes of the Babine and other mountain ranges of the Skeena system. While the data from stations in this region are meagre, they indicate an average precipitation of somewhere between 20 and 30 inches. The lowest precipitation is noted on the east side of the Hudson Bay and Rocher Déboulé mountains, which parallel a portion of the Bulkley valley. Here, the average precipitation is estimated to be slightly below 20 inches.

The temperature conditions of the Dry belt show greater extremes when contrasted with the Coastal belt. Since the meteorological stations are confined mostly to the valleys of the southern part of the region, it is not possible to express the temperature conditions in an average figure for the whole region. The stations situated in the valleys of the southern portion of the Dry belt show a mean annual average of 45°, with a winter mean of 25°, and a summer mean of 65°. The extremes vary from −45° to over 100°. The temperature of six stations situated mainly in the north-central portion of the Interior plateau show an annual average of 40°, with a winter mean of 16° and a summer mean of 57°. The lowest temperature recorded in this district is −55° and the highest 102°. While there are no meteorological stations in the Skeena system recording reliable temperature readings, the indications are that, latitude for latitude, the extremes are not so great as in the neighbouring northern portion of the Interior plateau. This, no doubt, is due to its prox-

imity to the equable climate of the Coastal belt. Temperature data are available from one station in the Yukon plateau, namely, Atlin (latitude 59° 35′, altitude 2,240 feet), which shows a mean annual of 30·5°, with a winter mean of 6·5° and a summer mean of 51°. The highest temperature recorded at Atlin is 81° and the lowest is −50°.

As one would expect, the mean average for the neighbouring uplands is lower than that of the stations situated in the valleys. Thus, Hedley (altitude 1,719 feet), has a mean annual temperature of 45°, with a winter mean of 25° and a summer mean of 64°, while the neighbouring Nickel Plate mine (altitude 4,500 feet) has a mean annual of 36°, with a winter mean of 20° and a summer mean of 52°. With the exception of the valleys of the southern portion of the Interior plateau and of some of the neighbouring lower portions of the uplands, as well as of areas that lie above the absolute timber line, the region of the Dry belt is timbered throughout. Within this vast region a number of different vegetative types are found.

Interior Wet Belt

After crossing the plateaus, the eastward-moving winds from the Pacific ocean strike the mountain ranges that border the plateaus on the east, and, being compelled to ascend their western slopes, a precipitation takes place which is greater than that of the Dry belt. This gives rise to a secondary moist belt, usually known as the Interior Wet belt. As defined here, this belt includes all the region occupied by the Monashee and Cariboo mountains, the Selkirk mountains, with the exception of portions of their east slopes, and portions of the west slopes of the Rocky mountains, from the northern boundary of the Railway Belt to and including a portion of the Parsnip River drainage.* Within this region the general average of precipitation is well over 30 inches and, in some cases, is as high as 60 inches. In the southern portion of this region the mountains are lower, and the valleys have, usually, a precipitation of from 20 to 30 inches. At the lower extremities of the Selkirk, Slocan and Kootenay trenches, there are small areas that have an average precipitation of slightly less than 20 inches. With one or two notable exceptions, the meteorological stations are in the region south of the northern boundary of the Railway belt and are situated in the valleys. The mountainous valleys tributary to the main trenches show a higher precipitation than the stations in the trenches themselves and a larger portion of this precipitation is in the form of snow. Thus, Revelstoke (altitude 1,497 feet) has a precipitation of 42 inches, one-third of which is in the form of snow ; while Glacier (altitude 4,094 feet) has a precipitation of 57 inches, nearly two-thirds of which is in the form of snow. Trail (altitude 1,367 feet), situated in the Selkirk trench,† is much drier

*Portions of the west slopes of the Cassiar and Omineca mountains might possibly be included in this wet belt. Reports of explorers indicate that these slopes have a heavier rainfall than the adjoining plateaus, but there are no specific data to show this definitely. Due to higher latitudes, the character of the vegetation here is entirely different from that of the region described above as the Interior Wet belt.

†No precipitation data available for this station ; total probably under 20 inches, one-third of which is snow.

than the neighbouring town of Rossland (altitude 3,400 feet) whose precipitation averages 30 inches, two-fifths of which is in the form of snow.

The most northern station for which precipitation records are available in this belt is at Barkerville (lat. 53° 02′ N., altitude 4,180 feet). Here the precipitation averages 34·5 inches, nearly one-half of which is in the form of snow.

The stations situated in the valleys of the southern portion of the Interior Wet belt have a mean annual temperature of 44°, with a mean winter average of 27°, and a summer average of 61°. The highest recorded temperature is 100° and the lowest is −17°. Contrasted with the temperature conditions of the southern portion of the Dry belt, the foregoing shows that the summers of the Interior Wet belt are cooler, the winters slightly warmer, and the extremes not very far apart.

With the exception of the mountainous area that reaches above the cold timber line, the entire area of the Interior Wet belt is capable of carrying forest growth.

Rocky Mountain Belt

As defined here, this belt includes the west slopes of the Rocky mountains, except certain valleys included in the Interior Wet belt and the drier portions of the Rocky Mountain trench. These exceptions include the portion of the Rocky Mountain trench from the Canadian Pacific railway southward, the upper portion of the Fraser River portion of the trench, and all that portion of the trench north of the middle portion of the Parsnip river. The exceptions also include the greater portions of the east slopes of the Purcell, Omineca and Cassiar mountains.

The climatic conditions within the Rocky Mountain belt are extremely variable and depend mainly on altitudinal and latitudinal variations. The climatic data are meagre and are confined almost entirely to the southern end of the trench. Here, the precipitation varies from 14 inches to about 20 inches, from one-fourth to one-third of which is snow. Generally speaking, as the slopes or the valleys of the Rocky mountains are ascended from the west, there is an increase in the precipitation up to some point west of the axis. Beyond, or to the east of this point there is again a gradual decrease toward the axis of the mountains and to the east of it. This is illustrated by the following table, which shows a one-year's record for four stations on the Crowsnest line of the Canadian Pacific railway :

	Altitude, feet	Rainfall, inches	Snow reduced to rain, inches	Total precipitation, inches
Cranbrook	3,019	12·39	3·87	16·26
Elko	3,089	18·69	7·29	25·98
Fernie	3,313	20·40	17·99	38·39
Crowsnest	4,451	9·02	2·70	11·72

Cranbrook is situated about the middle of the Rocky Mountain trench, Elko at the eastern edge, Fernie in the valley of the Elk river, a short distance

above Elko, and the Crowsnest is near the water-parting between the eastern and western slopes of the Rocky mountains. While these data were recorded in a year of exceptionally heavy precipitation for the region (1915), they are instructive as illustrating the variations discussed in the foregoing.*

These figures may perhaps be taken as indicative of the general conditions throughout the Rocky mountains. It will be noted that, reduced to a normal year, the precipitation for this portion of the Rocky Mountain trench is similar to that of the valleys of the southern part of the Dry belt, while that of Fernie corresponds to the drier portions of the Interior Wet belt ; again, the moisture conditions at Crowsnest are very similar to those of the Dry belt.

As will be shown later, localities in which the precipitation is approximately the same have forest types which also are similar in important respects. A one-year's record for one station, Tête Jaune, in the upper valley of Fraser river, and at the western base of the Rocky mountains, shows a precipitation of 16 inches. The character of the vegetation in the mountain valleys of the streams which enter this portion of the Rocky Mountain trench indicates that the precipitation in these valleys must be greater. The portions of the Rocky Mountain trench occupied by the Finlay, Kachika and lower Parsnip rivers have no meteorological stations, but, presumably, they have moisture conditions similar to the northern portion of the southern Interior plateau, with some increase for the minor valleys on either side.

In general, so far as temperature is concerned, the climate in the Rocky Mountain belt is more severe than that at corresponding points in the same latitude in the belts to the west. This is shown by the following table :

	Mean annual	Mean winter	Mean summer	Lowest recorded	Highest recorded
Trench stations in Southern Rocky Mountain belt................	40°	18°	60°	-51°	103°
Trench stations in Southern Interior Wet belt....................	44°	27°	61°	-17°	100°
Trench stations in Southern Dry belt	45°	25°	65°	-45°	103°
Trench stations in Southern Coastal belt........................	48°	37°	58°	-10°†	103°†

These figures show clearly that the greater the distance from the coast, the lower the average mean annual; also, with the exception of the 'trench' stations of the Southern Interior Wet belt, the greater are the extremes of temperature. This latter fact is probably attributable to the protection of the valleys of this region from the severe cold waves, and to the lower altitudes of the stations, as contrasted with those of the Rocky Mountain belt.

With the exception of very small areas of 'prairies' in the southern portion of the Rocky Mountain trench, and of the region above the absolute timber line, the land comprising the Rocky Mountain belt is all capable of carrying timber.

*The normal precipitation for Elko is about 20 inches.

†Station some distance from the coast. Stations on the coast rarely show a minimum of zero or a maximum of much over 90°.

Great Plains Belt

No reliable climatic data exist for the portion of the Great Plains region included within the limits of British Columbia. The nearest station for which there are any records is at Dunvegan (lat. 55° 56′ N., and long. 118° 35′ W.), on Peace river, 50 miles east of the British Columbia boundary. Here, the mean summer temperature is 58°, and the winter mean is 1°. The nearest station to this in British Columbia is at Fort St. James (lat. 54° 28′ N.), on Stuart lake, in the northern portion of the Interior plateau. Here, the summer mean is 53° and the winter mean is 12°. Thus, east of the Rocky mountains, at a station farther north, the summer mean is higher and the winter mean is lower than at a corresponding station west of the Rockies. From this it is inferred that the conditions for growth in the Great plains are better, so far as summer temperature conditions are concerned, than in the corresponding latitudes west of the Rockies.

No attempts seem to have been made to even estimate the amount of precipitation of the Great Plains belt in British Columbia. Judging from the character of the vegetation, the precipitation is much less than 20 inches and is probably about 15 inches or less. This portion of the Great plains is capable of carrying forest growth throughout, except for the large areas of swampy lands lying mostly in the northern portion. However, owing to repeated fires, large areas have been replaced by grass. (See Stand Type map.)

Summary

While there are well-defined climatic belts extending in a northerly and southerly direction, there are, within these belts, variations in precipitation and temperature which are due mainly to differences in latitude and altitude. While the vegetation of the Dry belt is strikingly different from that of the Coastal belt, yet it resembles the vegetation of the Rocky Mountain belt and of the drier portions of the Interior Wet belt. The moister portions of the latter belt have a vegetation very similar to that of the Coastal belt, and also to that of the moister portions of the Rocky Mountain belt. Again, the vegetation of the southern portion of any one of the belts is different from that of the central portion and this, in turn, differs from that of the extreme north. Therefore, the climatic belts cannot be considered as carrying single vegetative types, but groups of types, each of which may, or may not, be found in two or more of the climatic belts.

Forest Types

Over a given area, the atmospheric conditions of heat and moisture may be so similar as to favour the development of one species or group of a few species strongly dominating all others in the locality. This species or group of species gives a decided tone to the vegetation of the entire area ; and we may use the name or names of such species to designate this character. Such a conception of vegetation is sometimes called a *type* by foresters, and a *formation* by ecologists. To distinguish it from smaller units into which it may be divided, due

Plate VII

DEAD-TOPPED CEDAR WITH HEMLOCK AND BALSAM, HARTLEY BAY, DOUGLAS CHANNEL, COAST MOUNTAINS

MUSKEG TYPE, ON WEST SIDE OF GRENVILLE CHANNEL, COAST MOUNTAINS

mainly to different soil conditions within the area, it may be called a climatic type. These smaller units are sometimes called *sub-types* or merely *types* by foresters, and *associations* by ecologists.

Foresters usually distinguish the origin of the smaller units by prefixing descriptive adjectives. Thus, a *temporary type* or association is one which is due to the result of some interference with natural conditions and which will eventually be replaced by a different type. A *permanent type* (ultimate, natural or climax type or association) is one which will take possession of a given area if natural conditions are not disturbed.

This idea of temporary types may be carried further to include sub-units or units of vegetation on sites which are very unfavourable on account of the natural erosive forces. Bare rock surfaces, undrained or poorly drained swamps, and very sandy or pebbly soils, free of humus, all due to the erosive action of physiographic forces, such as the action of water, glaciers, wind, etc., carry a type of vegetation that may in geological periods be replaced by different types.

The tendency of all the temporary types as thus defined is, if left undisturbed by man, to progress by successive stages toward the *permanent type,* such a type being the highest expression of vegetation which the climate will permit. While it is conceivable that all temporary types will ultimately be replaced by the permanent type of the region, the natural process is slow and may occupy so long a time, covering centuries and, in some cases, geological ages, that, from the viewpoint of practical forestry, the existing temporary types must in many cases be considered permanent.

This has given rise to an artificial and, at the same time, practical conception that may be described as a *managerial type*. For example, over very large areas in British Columbia, portions of a number of permanent types have been replaced almost entirely by lodgepole pine, due to repeated fires. It is possible that, if fires are prevented for a very long period of time, such lodgepole pine forests will ultimately be replaced by the original permanent forest. However, if seed trees of the original type are far removed, it will take a large number of successive generations for the original forest to invade and replace the existing forest. It is more practicable to consider the lodgepole pine as a permanent unit from a management standpoint. It is not impossible that, in the future, new uses may be discovered for lodgepole pine which will make the large areas covered by this species even more valuable than the original type. Such a condition already exists locally in the vicinity of mines, where small-sized timbers are desired for development purposes.

Again, in certain portions of the province, where the original forest has already been destroyed by fire, the area has been invaded by grass and kept so, due to repeated fires. If fires were controlled, such areas would undoubtedly, in time, return to their natural conditions. It is, however, conceivable that the value yield per acre might be greater if such areas were utilized for grazing purposes than if managed in such a way as to allow the reinvasion of the original type. In certain districts, the advisability has been seriously considered

of extending the area of grazing land by intentionally burning off certain areas now clothed with young lodgepole pine forests.

The Stand Type map accompanying this report is an attempt to show roughly the distribution of the climatic types of the province. In some instances, due partly to the small scale of the map and partly to insufficient knowledge to definitely delimit the boundaries of the different types, two or more closely related types are indicated in one colour. Where climatic types have been largely or wholly destroyed by fire and have been replaced over large areas by a forest growth differing from the original—which may, or may not, be the managerial one—the name of the managerial type is coupled in the legend with that of the climatic type.

In the following discussion, types of vegetation which are closely related are placed under the same heading, corresponding usually to general similarity in conditions of precipitation.

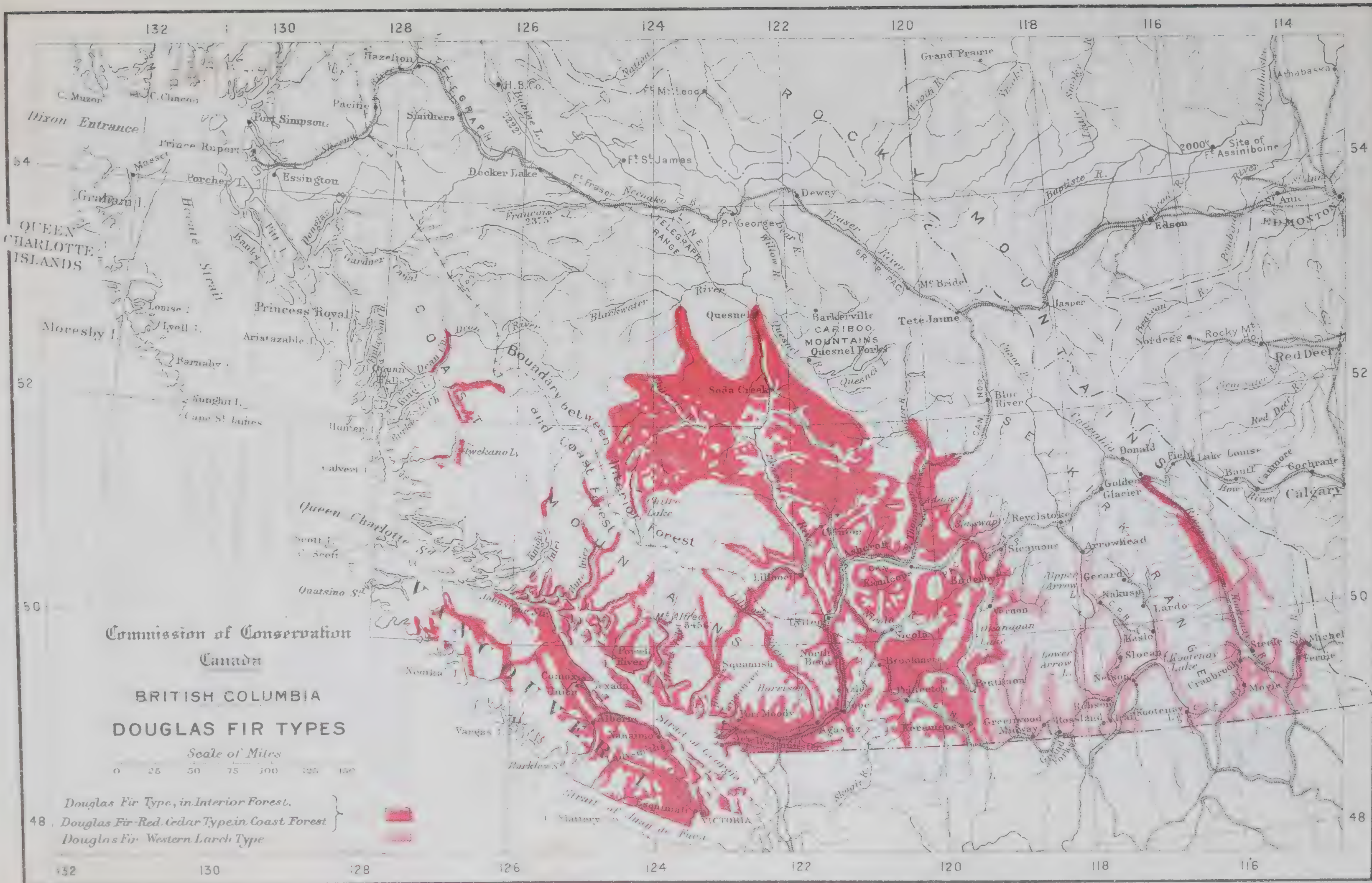
Forest Types of the Coastal Belt

The heavy precipitation and the mild climate which prevail along the Pacific coast are conducive to a luxuriant forest growth. With the exception of a small area on the southeastern portion of Vancouver island, the average annual precipitation in this belt exceeds 40 inches and, in places, reaches 120 inches.

Though very meagre meteorological data have been secured in this region, the following compilation of the records published by the Meteorological Service of Canada is suggestive as to the climatic conditions associated with the various forest types. It should, however, be noted that the stations where these records were secured are nearly all situated at or near tidewater and are not distributed in such a manner as to give altogether typical results.

Type	Temperature					Precipitation, in inches					Remarks
	Mean	Mean max.	Mean min.	Extreme highest	Extreme lowest	Rain: Mean annual	Rain: Driest year	Rain: Wettest year	Snow: Mean annual	Total *	
Douglas fir-Western red cedar	48·8	54·0	40·2	106	−13	47·42	22·02	89·00	29·8	50·40	16 stations, Vancouver island, and lower Fraser valley
Western red cedar-Western hemlock	47·9	54·3	41·5	91	4	104·88	56·53	147·53	14·4	106·32	3 stations, west coast Vancouver island
Western hemlock-Sitka spruce	45·4	52·6	38·1	99	−18	69·63	30·40	127·95	61·8	75·81	5 stations, northern coast and Graham island
Western hemlock-Balsam	46·3	52·0	40·7	88·0	9·0	112·15	67·16	144·14	13·7	113·52	2 stations, north end of Vancouver island

*The figures for total precipitation are secured by adding the mean annual rainfall and the water equivalent of the mean annual snowfall, 10 inches of the snowfall being taken as equivalent to 1 inch of rainfall.



Accompanying report on "Forests in British Columbia" by H. N. Whitford, Ph. D., and Roland D. Craig, F.E.

Base map from plate of Map of Dominion of Canada, Dept. of Interior

The forests in this belt, as elsewhere in British Columbia, are primarily coniferous, the principal species of trees being, in order of predominance: Douglas fir, western red cedar, western hemlock, balsam (amabilis fir, lowland fir and alpine fir) Sitka spruce, yellow cypress, western white pine, lodgepole pine, besides cottonwood. With the exception of Douglas fir, lowland fir and western white pine, these species are distributed generally throughout the Coastal belt. Climatic variations result, however, in the local predominance of the species best adapted to the prevailing conditions, so that the following five main climatic types are distinguished:

Douglas fir-Red cedar type	Hemlock-Sitka spruce type
Red cedar-Hemlock type	Hemlock-Balsam type

Sub-alpine and muskeg type

In general, these types follow the foregoing sequence, both altitudinally and latitudinally, except that the hemlock-Sitka spruce type is distinctly a lowland type. Local soil and topographical conditions, which vary so greatly in a mountainous region such as this, cause so many modifications in the forest growth that it is impossible, except in a general way, to indicate the distribution of each type. For example, typical cedar-hemlock forests may be found on the northern slopes in a locality generally covered by the Douglas fir-cedar type, and stands of hemlock and spruce usually occur in the valley bottoms in all types.

Douglas Fir-Red Cedar Type

In this type, Douglas fir and red cedar form at least 50 per cent of the stand. Its distribution coincides closely with that of Douglas fir, since this species usually predominates when present. It is the prevalent type at the lower altitudes in the southern, eastern and central portions of Vancouver island, extending as far north as Nimpkish lake, and also on the mainland and adjoining islands from the international boundary to Knight inlet, reappearing at the upper reaches of the fiords, as far north as Gardner canal. In general, it may be said that this type occurs only in regions where the annual precipitation is less than 75 inches, and that it reaches its best development where the precipitation is between 50 inches and 60 inches, not more than 5 per cent of which is in the form of snow.

It is probable that light conditions are of more direct importance than precipitation in the development of this type. Douglas fir is more light-demanding than any of the associated species except western white pine, and, since the amount of sunlight available is more or less in inverse proportion to the amount of precipitation,* the more shade-enduring species have an advantage over the Douglas fir in regions of high precipitation.

This type extends from sea-level to an altitude of from 2,000 feet to 2,500 feet, and occasionally, to 3,000 feet in the southern portion of its range. Towards the northern limit the altitudinal range decreases. It usually attains its best development below 1,500 feet.

*An exception to this rule is found on the low-lying lands on Graham island, Q.C.I., where there is a great deal of cloudy weather, though the amount of precipitation is small as compared with that on the adjacent mainland.

Associated with the determining species, the following occur, in the order of their relative importance : Hemlock, balsam (amabilis fir and lowland fir), Sitka spruce, western white pine, cottonwood and lodgepole pine.

Douglas fir thrives best on deep, rich, well-drained soils, but it will grow on steep and rocky sites where the supply of soil moisture is not sufficient for cedar or hemlock. In wet situations, such as close to the banks of rivers, it usually gives place to Sitka spruce, red cedar and balsam, and, around upland marshes, it is replaced by western white pine, hemlock and balsam. Though it does occur in almost pure stands in some places, as, for instance, on Texada island and on the southeastern part of Vancouver island, it is usually concomitant with other more shade-enduring species. Throughout the type it forms on the average about 45 per cent of the stand.

Red cedar thrives best in the more moist situations, but usually grows wherever Douglas fir does and maintains its vigour on higher and less propitious sites. It attains its highest individual development in this type and forms on the average 30 per cent of the merchantable stand.

Western hemlock occurs almost everywhere throughout the type, increasing in prominence at the higher elevations and on less favourable sites. It is usually of a better quality on higher situations, being, on the lowlands, more subject to defects though of larger size. Although of minor commercial value, it forms 15 per cent of the merchantable timber in this type.

The two species of balsam, or 'larch' as they are locally, though erroneously, known, are, as a rule, confined in the virgin stands, to either the damper or the higher sites ; the lowland fir to the former and the amabilis fir to the latter. Approximately 7 per cent of the stand is balsam.

Sitka spruce occurs in this type only on the well-watered lands along the valley bottoms or close to the shore, and is seldom found at more than 1,000 feet above sea level. Though of considerable commercial importance in the type, it forms on the average only about 2 per cent of the stand.

Western white pine is a typical species of this type, but it is not so generally distributed as Douglas fir. It never occurs in pure stands and seldom forms over 5 per cent of the stand on any area exceeding 100 acres. Altogether, it comprises only about 1 per cent of the total stand of the type. This is doubtless due to its intolerance of shade, since it is rarely found in dense stands, but occupies rocky knolls or the edges of openings in the forest caused by windfalls, burns or marshes. It is distributed from sea level to an altitude of 2,500 feet. Though not found in sufficient quantity to make it of especial commercial value, it is an excellent wood, closely resembling the eastern white pine.

Cottonwood occurs in the same sites as Sitka spruce and is typically a pioneer species on alluvial soils, gradually becoming replaced by conifers as the further building up of the land or the erosion of the river beds lowers the water level. It forms only a very small percentage of the stand in this type, but, owing to the special uses for which the wood is adapted, such as the manufacture of boxes, veneer and carriage stock, it is of considerable value.

Lodgepole pine, as it grows on the coast, is a scrubby tree of practically no commercial value. It usually skirts the edges of the shore or marshy places in the forest.

From a commercial standpoint, the Douglas fir-cedar type is the most important in British Columbia, producing not only the heaviest stands, but also the finest quality of timber. Stands exceeding 50,000 b.f. per acre occur over large areas and frequently over 100,000 feet per acre is found on small specially favourable situations. Mature fir trees usually contain from 2,000 b.f. to 6,000 b.f. and often exceed 10,000 b.f. Sitka spruce reaches about the same size as Douglas fir. Red cedar, though frequently 5 to 8 feet in diameter breast high, does not scale so high as fir or spruce, owing to the more rapid tapering of the bole. However, single mature trees usually contain from 1,000 b.f. to 3,000 b.f. and frequently over 5,000 b.f.

Douglas fir is the most useful wood on the Pacific coast for general construction, and is, as yet, practically the only wood in demand for the export trade to the British Empire and to foreign countries other than the United States.

Most of the forests of this type are situated within twenty miles of the navigable and protected waterways tributary to the gulf of Georgia, a large proportion being directly at tide-water. This renders it the most accessible timber in the province and it has therefore been the most heavily exploited.

Fires have done extensive damage in this type, expecially on the drier sites. The increased hazard due to the extensive logging operations is largely responsible for this damage, although the drier climate of the region and more inflammable nature of the Douglas fir and red cedar, as compared with the hemlock and spruce of the adjoining types, are no doubt important factors in this connection.

Generally speaking, the natural reproduction of the fir and cedar is being accomplished satisfactorily, except where fires occur repeatedly. In order to secure the reproduction of these species after logging, slash burning has been found necessary, to remove, not only the resulting debris but the hemlock and balsam reproduction, which, owing to the shade-enduring characteristics of these species, usually becomes established under the mature stand.*

Red Cedar-Hemlock Type

As Douglas fir disappears from the stands in the north or at the higher altitudes, red cedar becomes the predominating species, with western hemlock as second in importance.

As a rule this type occupies a zone above or to the north of the Douglas fir-red cedar type. In the southern portion of the Coastal belt this zone is usually at an altitude of from 1,500 feet to 3,000 feet above the sea, sometimes reaching 4,000 feet. The altitude at which it occurs gradually decreases toward the heads of the fiords and toward the north until it descends to the water's

*A report on this subject, by Dr. C. D. Howe, is contained in the report on *Forest Protection in Canada, 1913-1914*, published by the Commission of Conservation in 1915.

edge between Knight inlet and Rivers inlet on the mainland, and between Barkley sound and Quatsino sound on Vancouver island, where altitudinal distribution of the type varies from sea level to about 1,500 feet.

The climatic conditions of this type are more severe than those of the Douglas fir-red cedar type. Though the mean temperature is only slightly lower, the precipitation is heavier, ranging from 90 inches to 120 inches and averaging about 106 inches per annum. On the west coast of Vancouver island the available records indicate that only from one to two per cent of the precipitation falls in the form of snow. On the mainland, however, the percentage of snow is undoubtedly much higher. The species associated with the red cedar and hemlock in this type are balsam (amabilis fir and lowland fir), Sitka spruce, yellow cypress, cottonwood and lodgepole pine.

Commercially, the red cedar is the most important species in this type, and, at present, is being logged extensively, owing to the demand for shingles and cedar lumber. It forms on the average about 50 per cent, and frequently exceeds 60 per cent, of the stand in this type.

Western hemlock assumes a more important place in this type than in the Douglas fir-red cedar type, and constitutes, on the average, 25 per cent of the stand. In the cedar-hemlock type it is one of the dominant species and the timber is generally of better quality than when dominated by Douglas fir, as is the case in the Douglas fir-red cedar type.

Hemlock is being used chiefly in the manufacture of pulp and paper, and it is in this type that most of the pulp leases on the southern portion of the coast are situated. Its value for lumber is, however, becoming more generally appreciated, and the commercial value of this species will, undoubtedly, be materially enhanced in the near future.

Balsam, like hemlock, is chiefly used for the manufacture of pulp and paper, though for some purposes, such as box manufacture, it is used as saw-material. It seldom comprises more than 25 per cent of the stand in this type and averages about 12 per cent.

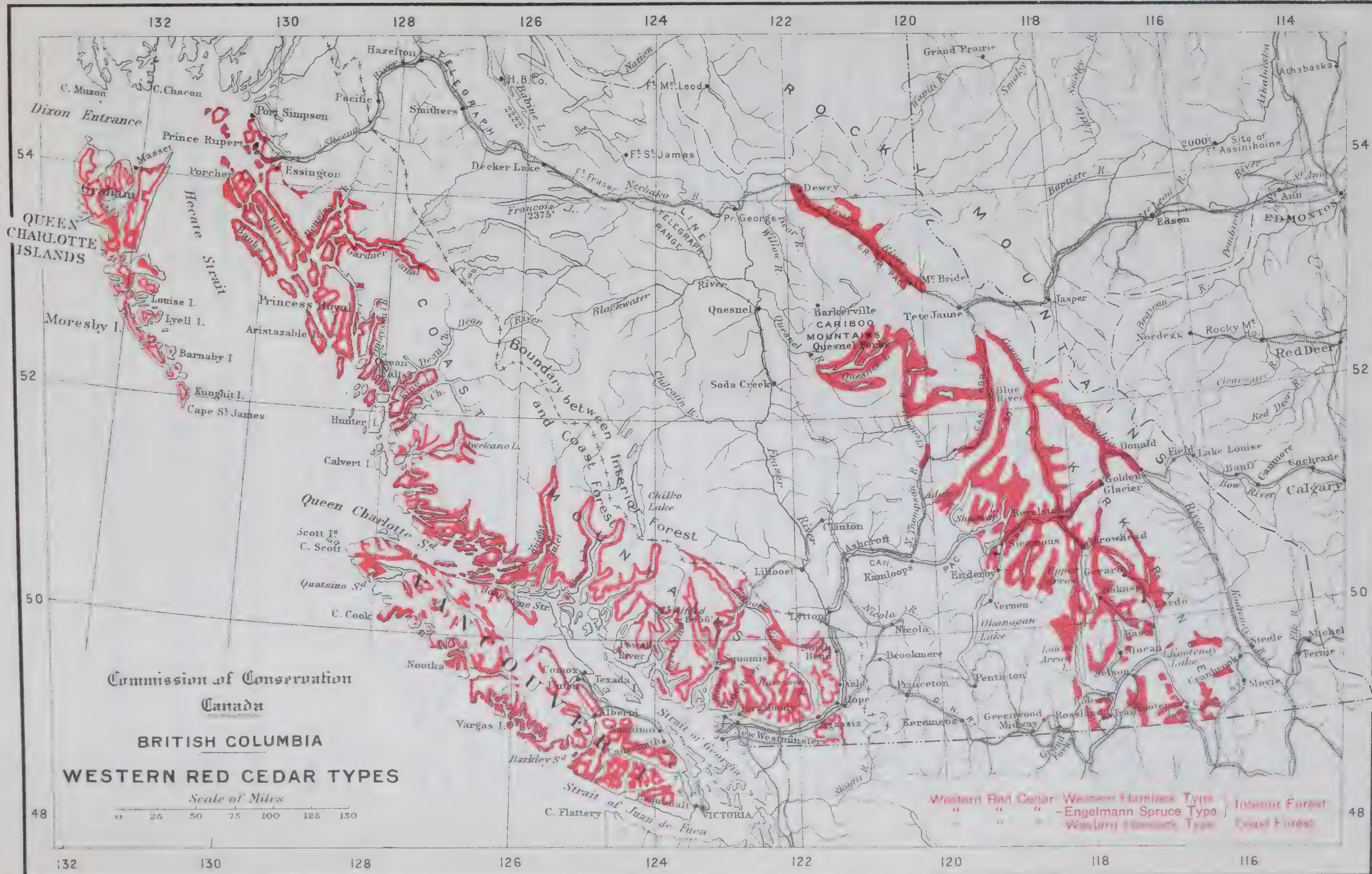
Sitka spruce forms a relatively small proportion of the stand, seldom exceeding 10 per cent over any large area, averaging about 5 per cent throughout the type. Owing, however, to the excellent quality of the wood, both for lumber and woodpulp purposes, and especially in the manufacture of aeroplanes, it almost equals the hemlock in value in this type. Spruce is confined to the lower levels, either close to salt water or in the valley bottoms, where it attains large dimensions, frequently exceeding six feet in diameter.

Yellow cypress attains its best individual development in this type and is a valuable wood. It is stronger and more durable than most coniferous woods and does not warp or 'work' much with changes in moisture. At present, however, as it is scattered and more or less difficult of access, it is not being utilized to any large extent. As a rule it is confined to the upper limits of the type, though in the more exposed, colder or wetter sites it occurs at tidewater. It seldom forms more than 10 per cent of the stand over any considerable area, though it occasionally occurs in almost pure stands in small valleys

Plate VIII

MUSKEG TYPE, SOUTH OF MASSET INLET, GRAHAM ISLAND, QUEEN CHARLOTTE ISLANDS

SPRUCE, HEMLOCK AND CEDAR, MORESBY ISLAND, QUEEN CHARLOTTE ISLANDS



Accompanying report on "Forests in British Columbia"
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Base map from plate of Map of Dominion of Canada, Dept of Interior

at the higher elevations. Approximately three per cent of the timber in this type is yellow cypress.

Cottonwood does not occupy an important position in this type. Its occurence is limited to the larger valley bottoms, where it forms only a relatively small part of the stand. Lodgepole pine is also of negligible commercial value in this type.

The damage by fire has been comparatively small, owing, largely, to the damp climate, but also to the fact that, until recently, the forests in this type have not been extensively logged.

Western Hemlock-Sitka Spruce Type

This is typically a lowland type, seldom occurring at altitudes of more than 1,000 feet above sea level, usually below 500 feet. Hemlock and Sitka spruce are more tolerant of shade and excessive moisture than red cedar, and are thus enabled to thrive under conditions which the cedar finds difficult. This type is found in the damper situations within the normal ranges of both the Douglas fir-red cedar type and the red cedar-hemlock type. It is the prevailing type, however, in the coastal region between Rivers inlet and the head of Portland canal, and on Queen Charlotte islands.

Within the range of this type the average annual precipitation varies from 42 inches to 112 inches, averaging about 76 inches,* of which one to two per cent is in the form of snow. An important factor in determining the distribution of this type is the relative lack of sunlight due to the large amount of cloudy weather which prevails, even in localities where the precipitation is not high. The Queen Charlotte islands afford an instance of this, the precipitation being only 52·25 inches.

In this type, the western hemlock forms from 25 to 45 per cent of the stand, averaging 38 per cent. Sitka spruce forms from 20 to 35 per cent and averages 27 per cent. Associated with these determining species are red cedar, balsam (chiefly amabilis fir), yellow cedar and cottonwood. Red cedar comprises about 21 per cent of the stand. Balsam forms 15 per cent of the stand on the mainland, but, as it is not found on Queen Charlotte islands, the percentage for the whole type is reduced to 11 per cent. Yellow cypress forms two per cent and cottonwood one per cent of the stand in this type.

It will be seen from the foregoing that this type as a whole offers special opportunities for the development of the pulp industry. All of the species, with the exception of red cedar and yellow cypress, are suitable for this purpose.

There is no doubt that the pulp and paper industry will become the most important forest industry in the region where the hemlock-Sitka spruce type prevails. Extensive areas of this timber have been taken up as pulp leases and pulp mills have already been established at Ocean Falls and Swanson Bay.

*These figures were obtained from the reports of the Meteorological Service of Canada. In a chart published by the Department of Lands, Victoria, for 1912, the precipitation is shown as varying from 70 inches to 170 inches, averaging 100 inches.

The hemlock in this type is generally of good quality ; that on the Queen Charlotte islands is perhaps the finest on the coast. Sitka spruce, in this type, is not, as a rule, of so good a quality as that grown on more favoured southern sites. Nevertheless, in the valley bottoms and along the shores of the protected waterways, both on the mainland and on Queen Charlotte islands, it attains large dimensions and will provide excellent saw-material.

The cedar, though very good in the more favoured situations, is, on the whole, inferior in quality to that found in the previously described types. It is inclined to be short-boled, limby and to taper quickly from the butt. The dead tops of the cedar are conspicuous, indicating an unhealthy condition, the immediate cause of which has not been determined. The same is true, in general, of the yellow cypress.

On the bottom lands of some of the larger valleys, such as the Skeena and the Nass, excellent stands of cottonwood are found.

Owing to the dampness of the climate and to the fact that these forests have not been extensively exploited, the fire damage has been comparatively light in this type, and the forest is practically in its virgin state.

Western Hemlock-Balsam Type

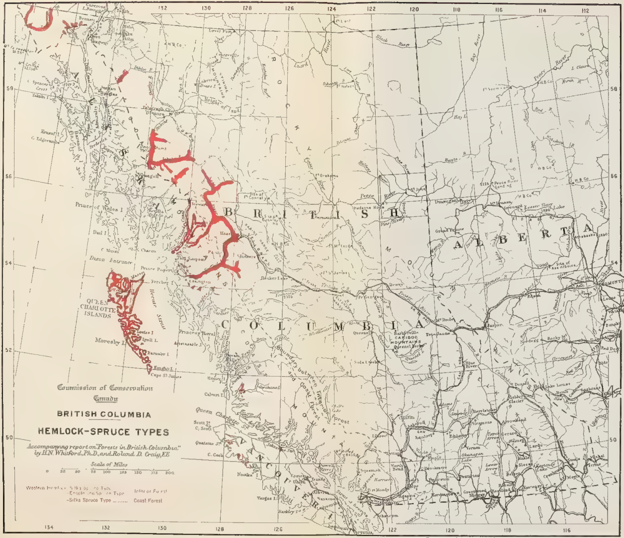
This type occupies a climatic zone somewhat less favourable than that of the red cedar-hemlock type or the hemlock-Sitka spruce type. It occurs either at higher altitudes, or on more exposed or wetter sites. Though not always present in the southern portion of the province, it is found there in some localities above the cedar-hemlock type at elevations between 1,500 feet and 3,500 feet, extending in some cases as high as 4,000 feet, depending on the topography.

This is the prevailing forest type on the north end of Vancouver island, especially in the vicinity of Quatsino sound. It occurs also on the mainland from Queen Charlotte sound to the head of Portland canal, above the hemlock-Sitka spruce type, or farther inland in the terminal valleys of the fiords.

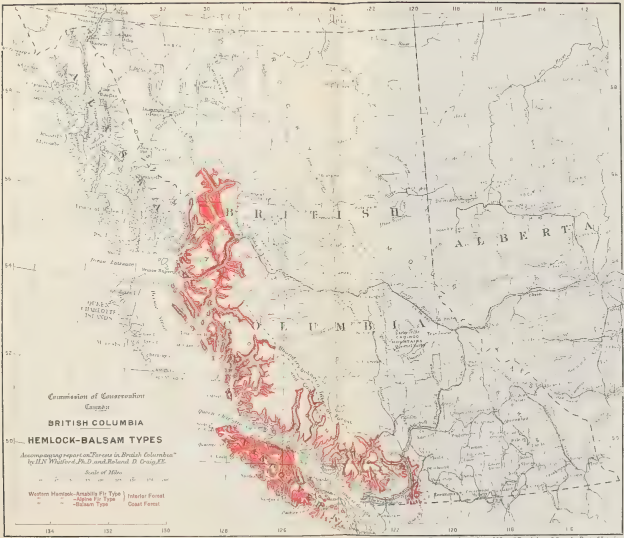
Where this type occurs, the total precipitation and the percentage of snowfall are generally higher than in the previously discussed types, or else the temperature is lower. The only localities in this type from which meteorological records are obtainable are two stations on the north end of Vancouver island, where the average precipitation is given as 113·5 inches. In the terminal valleys of the northern fiords, however, the precipitation is considerably less, but the percentage of snow is higher and the mean temperature lower. In the valley extending from Kitimat river to Nass river, heavy stands of this type are found, though the precipitation there is lower than in the adjoining hemlock-spruce type.

Western hemlock and balsam are the predominating species. The balsam is mostly amabilis fir, with perhaps some alpine fir in places. The composition of the stand is approximately as follows : Hemlock, 50 per cent ; balsam, 30 per cent ; red cedar, 15 per cent ; yellow cypress, 5 per cent.

The quality of the hemlock and balsam is generally very good, while that of the red cedar and yellow cypress is about the same as in the hemlock-Sitka



Base map from plate of Map of Dominion of Canada, Dept. of Interior.



Base map from plate of Map of Dominion of Canada, Dept. of Interior

spruce type. The hemlock-balsam type is essentially a pulpwood type. On Quatsino sound a considerable area of it has been taken up under pulp leases, and a pulp mill is under construction to utilize the timber.

Except in the interior valleys, where the annual precipitation is light, little damage has been done by fire and the forests are still awaiting development.

Sub-alpine and Muskeg Types

At the higher elevations between the merchantable timber-line and the cold timber-line, there occurs a type of stunted tree growth composed chiefly of mountain hemlock, yellow cypress and alpine fir, with, in places, an admixture of red cedar, lodgepole pine or white-bark pine.

A similar type is found on very wet or exposed situations, at low elevations along the coast. The tree species growing on these lower sites are yellow cypress, mountain hemlock, western hemlock, red cedar, Sitka spruce, amabilis fir and lodgepole pine. As a rule, a considerable proportion of the area in this type is treeless, the soil being wet and covered with a thick growth of moss. This muskeg type, as it is called, is most pronounced on the flat lands on the north end of Vancouver island and on Graham island. When drained, these lands can be utilized for agriculture and a considerable area has been taken up for this purpose, either by pre-emption or by purchase. On the outside islands along the northern coast, a large proportion of the forest is of this type, though the topography is usually broken and the underlying soil rocky.

The sub-alpine and muskeg types do not carry merchantable timber according to the statutory definition, nor can they be expected to do so within the limits of the present administrative objective. From the viewpoint of forest production, therefore, these types must be considered waste-lands, and they have been so designated on the accompanying Stand Type map.

Forest Types of the Interior—Treeless and Semi-Treeless Types

Sage-Brush Type

In accordance with its name, this type is characterized by the prevalence of sage-brush (*Artemisia tridentata*). There is no tree growth, save along streams and where seepage water supplies sufficient moisture.

This type occupies a narrow belt on the lower benches along the Fraser river, and a short distance up its tributaries, from near the mouth of Chilcotin river to near the mouth of the Thompson. It is found in similar situations along the Thompson, from near its mouth to the town of Kamloops and a short distance up the tributaries of this river, especially along the Bonaparte and Nicola rivers. It occurs also along the lower reaches of Okanagan river, from the foot of Okanagan lake to and beyond the international boundary. It is found along the Similkameen river, from near the town of Keremeos to and beyond the southern boundary of the province. It thus occupies the lowest valleys of the southern portion of the Interior plateau, its altitudinal range

being from 700 to 1,400 feet. On southern exposures it is found at somewhat higher altitudes than on northern exposures.

Where this type is found, the annual precipitation is usually below 10 inches, and the summer temperature is the highest in the province.

Where water is supplied by irrigation, agricultural crops can be produced on this type. The principal ones cultivated are alfalfa, vegetables and fruits. Only a very small portion of the area is as yet actually utilized for this purpose.

Grass and Semi-Open Forest Types

These two types are closely related. They include not only the natural grass lands of the province, but also the transition between these and the forest types bordering them, as well as the grass lands made so by repeated fires. The lines between these are not always clear. They flank the sage-brush type, in some places in narrow strips, in others broadening out and extending well up the slopes of the valleys and even in places on to the uplands. In all instances they continue further up the valleys of the main and side streams in the southern plateau region than they do further north.

Besides the streams already mentioned, these types occur also along the lower portion of Kettle river. In the southern portion of the Rocky Mountain trench there are three such areas, one on the east side of Kootenay river, known as the Tobacco plains ; one north of St. Mary river, called St. Mary prairie, and a third around the lakes at the headwaters of the Columbia river. The areas of these are small.

Fire-made grass lands occur throughout the drier portions of the forested districts of the province. In the Peace River district these areas are extensive. In other regions, their areas cannot even be approximated. The natural grass lands occupy a region where the annual precipitation is between 10 and 15 inches, and where the summer temperature conditions are slightly lower than those of the sage-brush type. The altitudinal range of the grass lands is usually from 1,000 to 3,000 feet, though the range for any particular region is usually much narrower than this. It extends to higher altitudes on southern exposures than on northern ones.

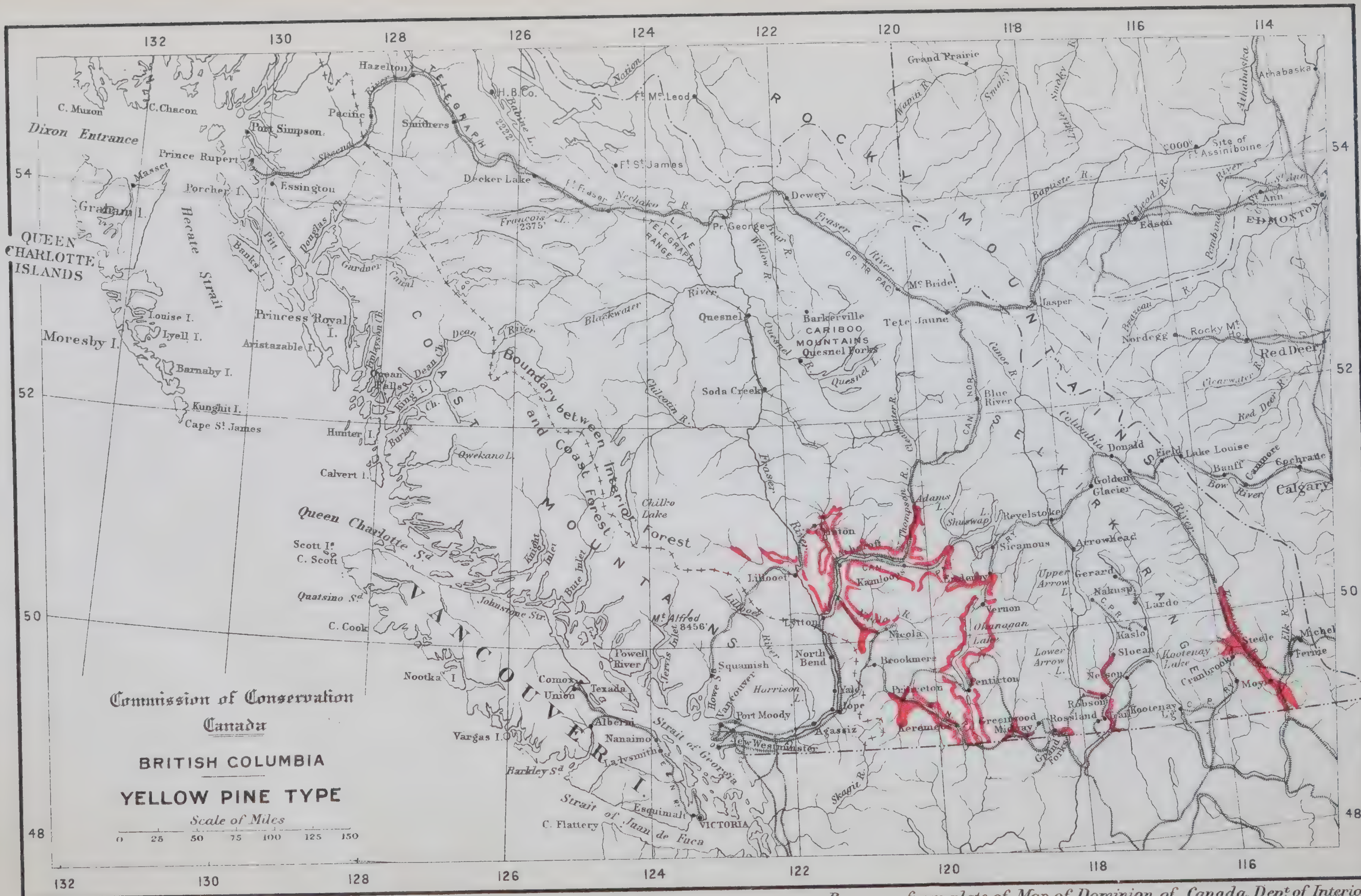
The most characteristic plant of the natural grass lands in the southern part of the Interior system is the bunch grass (*Agropyron spicatum*). Over some areas it has been practically exterminated by over-grazing. The semi-open forest that borders the grass land is occupied by scattered trees of the neighbouring types, principally western yellow pine, Douglas fir and lodgepole pine. Throughout the grass lands and semi-open forest, as shown on accompanying map, there may be islands of tree growth either on moister sites or, in case of fire-made grass lands, comprising remnants of the original forest. As stated in the foregoing, there is no doubt that the grass lands of the province have been much extended through the complete destruction of the forest by fire. On the other hand, where fires have ceased, the forest is again invading the places it once covered, especially on northern slopes.

Where irrigation is possible, the grass lands of the valleys are the best agricultural regions of the province. The crops raised are mostly fruit, vege-

Plate IX

SEMI-ARID CONDITIONS EAST SIDE OF COAST MOUNTAINS, CAYUSE CREEK, FRASER RIVER

SPRUCE, BALSAM AND LODGEPOLE PINE FORESTS, IN INTERIOR PLATEAU, NEAR PENTICTON, ALTITUDE 6,500 FEET



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tables and forage, with some grain. Probably some of the 'artificial' grass land in the Peace River district will be used for wheat growing. The greater part of the area occupied by the grass and open forest types, however, is best suited for grazing purposes, and is so utilized at present. The areas that can be farmed are relatively small.

Yellow Pine Type

This type covers areas which, when left undisturbed, contain a stand of 50 per cent or more of western yellow pine. It is found usually on dry, well-drained soils at altitudes between 1,500 to 2,500 feet above sea level ; on exposed southerly slopes, the type may extend up to an elevation of 3,500 feet. In some localities the stand consists altogether of yellow pine, but, where it borders on the Interior Douglas fir type, the yellow pine is mixed with Douglas fir and lodgepole pine. Where it borders on the Douglas fir-western larch type, a percentage of the stand is western larch, Douglas fir and lodgepole pine.

Where the yellow pine type prevails, the precipitation is from 14 inches to 18 or 20 inches. The type is usually confined to upper bench lands and slopes and, sometimes, to the lower benches and floors of the valleys of the southern portion of the Southern Interior plateau. It is found also in the extreme southern portion of the Selkirk and Rocky Mountain trenches, and it occurs as islands on especially warm sites in the Douglas fir-western larch type.

Occasionally, small areas in the western yellow pine type have stands of as much as 15,000 board feet per acre, but such heavy stands are not common. The average is usually between 5,000 and 10,000 board feet per acre. Owing principally to its accessibility, the lumbermen have made greater inroads on this type than on any other. Practically all the timber of this type has been alienated from the Crown, and the land held under lease or in limits is usually thrown open for agricultural purposes when the timber is cut. Much of such land is better suited for raising timber than for growing crops. At least, it could be more advantageously used for timber production in combination with grazing. In especially favoured places, where irrigation is practicable, or where the soil is such that dry farming can be successfully carried on, lands are being utilized for farming purposes, especially for growing fruit, forage and grain. The total area of this type actually employed for such purposes is, however, very small.

The yellow pine type as a whole is fairly open, and patches of open grass lands of considerable size sometimes occur. Practically the only inflammable material on the forest floor is grass. The result is that, while surface fires are frequent, crown fires seldom occur. In many places, however, surface fires have succeeded in destroying the reproduction. On the other hand, where fires have not occurred for some years, the young forest growth is generally sufficient to restock the cut-over areas.

Lodgepole pine has frequently invaded burned-over areas of the yellow pine type, but this does not occur so often in this type as in some of the others.

Interior Douglas Fir Type

In this type, 60 per cent or more of the stand was originally Douglas fir. The area covered by it has been so devastated by repeated fires that lodgepole pine has replaced the original forest over a great part of the region. The climate of the area within which this type occurs resembles that of the yellow pine and the Douglas fir-larch types.

In the southern portion of the Interior plateau (south of lat. 51° N.), the Douglas fir type usually occupies a zone lying altitudinally just above the yellow pine type. Here, its lower altitudinal range varies from 2,000 to 2,500 feet above sea level, and its upper from 4,000 to 4,500 feet. On southern aspects, it extends to higher elevations than on northern. In the Southern Interior plateau, between lat. 51° N. and 53° N., it borders on the grass lands, and its lower general altitudinal range is between 2,500 and 3,500 feet above the sea, but, on northern aspects, it may occur as low as the 2,000-feet contour ; on southern slopes, it may extend upward to 4,500 feet altitude.

The precipitation over this type varies, usually, from 15 to 18 inches, though, farther north, the total is sometimes less than 15 inches. Outside the Southern Interior plateau, a good example of the type occurs in the Rocky Mountain trench from the head of the Columbia river to near the town of Golden. Here it covers the benches, extending from an altitude of 2,000 feet to about 3,000 or 3,500 feet.

Throughout the range of the Douglas fir type, at its upper altitudinal and latitudinal limits it merges gradually into the Engelmann spruce type. It thus occupies a climatic zone that is intermediate in temperature conditions between the yellow pine and the Engelmann spruce types. Where it borders on the yellow pine type a percentage of the stand is yellow pine. Islands of yellow pine occur on the warmer sites within the Douglas fir type. Where it borders on the Engelmann spruce type a percentage of the stand is Engelmann spruce, especially in cooler ravines and on northern slopes.

The Douglas fir in the Interior Douglas fir type differs markedly from that of the Douglas fir of the coast. As one traverses the low passes of the southern Coast mountains it will be noted that, as the Dry belt is approached, the tree gradually becomes smaller in size, the bole is shorter and more limby, and the bark more closely ridged. In the Dry belt, while individual trees may reach a diameter of as much as six feet, the bole tapers rapidly, and seldom can more than three or four 16-foot logs be obtained from a single tree. On the best sites, stands may total 8,000 to 10,000 feet per acre, though the stand per acre over large areas will usually average under 5,000 feet.

Due to repeated fires, Douglas fir has been replaced over large areas by lodgepole pine. So extensive has been the replacement that the Douglas fir type, as a whole, gives the aspect of a permanent lodgepole pine type, and, in future management, the lodgepole pine is, for practical purposes, likely to be the most important tree from the forester's viewpoint. Due partly to the fact that the lodgepole pine forest cover has not usually reached merchantable size, and, partly, because of its relatively small size when it does reach maturity, very

little of it is being cut ; on the other hand, small operators scattered throughout the region are utilizing the remnants of Douglas fir stands that have escaped destruction by fire. In some places, where fires have not been too frequent, there is a fair stand of young Douglas fir mixed with the lodgepole pine. Such regions, if protected from further damage, will eventually restock with a Douglas fir forest.

Scattered throughout the Interior Douglas fir type are open grassy glades in the forest. Sometimes such openings are only a few acres in extent, while, in other cases, they cover several square miles. As to physical condition, the soils in these grass areas may be dry or wet. The dry glades may be natural or artificial. The naturally dry glades occupy sites on which the soil conditions are too dry to support tree growth. Such sites partake of the nature of the grass type already described. The artificial glades are due to the complete destruction of the forest growth by fires, with subsequent invasion of grass.

The wet glades or meadows are swampy in nature. The area of the Douglas fir type is dotted with drained or partially drained glacial depressions. Some of these are occupied by lakes, around which are zones of grass and sedges. Other depressions are, during the wet seasons, filled, or partially filled, with water. Such depressions become sufficiently dry during the summer season to support a luxuriant meadow growth. Usually occupying a zone around the meadow, in slightly drier soils, is a belt of shrubby growth of willows and alder. The water area of the depressions is often increased by beaver dams, the destruction of which would lower the water level of the beaver ponds and thus increase the area occupied by meadows.

As implied in the foregoing, lumbering operations in the Douglas fir type are not extensive. The main value of the type lies at present in the grazing of stock. The best grazing is in the open glades, both wet and dry. Many of the wet meadows, especially when cleared of willows and alders, will produce good crops of hay for winter forage. Within the forest itself, more or less grazing and browsing is available, especially where the forest is partially open, thus allowing the establishment of forage grasses and weeds. While the value of the forest grazing per unit of area is relatively low, the area in forest is so great that large numbers of stock can find subsistence.

In this connection, the question has been raised as to whether much of the area of the Douglas fir type cannot be made to yield better financial returns if the forest growth, especially the lodgepole pine, were to be completely destroyed, thus allowing the invasion of grass and other forage plants for grazing purposes. It is argued that certain regions could thus be turned into grass lands and be made to yield a greater return per acre, for the present, than in forest. If such a policy were adopted the areas considered for such treatment should be carefully investigated. This study should include consideration of the possible effect of the removal of the forest growth from the watersheds. Also, an investigation should be made of the life-history and behaviour of the forage plants that are expected to invade the burned-over regions. Experimental plots should be placed under observation and study for a period of

years before adequate conclusions could be reached. To conduct such a study, training in modern ecological methods of investigation is necessary.

In addition to the areas suitable for grazing, there are certain warm sites with favourable conditions which are suitable for dry farming. Other sites, where irrigation is practicable, could be made to yield forage crops for winter feeding.

Douglas Fir-Western Larch Type

This is a complex type and, due to disturbance by fires, it is possible to give only a general idea of its character and limits. In general, it may be defined as a type in which 50 per cent or more of the stand is Douglas fir and western larch. It is confined to the south-eastern portion of the province, usually below 50° N. latitude, but in some places it extends north to 50° 30′ N. Its western boundary is approximately the Okanagan valley.

Western larch is the key tree to the type, as defined. On some sites it comprises by far the largest percentage of the stand ; on others, its proportion may be as low as 10 per cent.

The moisture conditions of this type are intermediate between those of the yellow pine type on the one hand, and the western cedar-western hemlock type on the other. The precipitation is generally between 18 and 25 inches.

As to temperature conditions, the type is intermediate between the yellow pine type on the one hand, and the Douglas fir type of higher latitudes and the Engelmann spruce type of higher altitudes on the other. Its altitudinal range is usually between 1,800 feet and 3,500 to 4,000 feet. Where it borders on the Engelmann spruce type, a percentage of the stand is Engelmann spruce and alpine fir.

The composition of the Douglas fir-western larch type has been changed by fire. After the first few fires in virgin areas, the percentage of larch in the invading stand is likely to be much increased, owing to the fact that the bark of this species is thicker and offers more resistance to fire than that of any other species associated with it. This is especially true where the type borders on the Engelmann spruce and the cedar-hemlock types. It is probably true that some of the area of the Douglas fir-western larch type, as shown on the map, was originally occupied by the other types mentioned in the foregoing discussion ; due, however, to the inroads of fire, they were replaced by the Douglas fir-larch type. On the other hand, repeated fires have, over large areas, resulted in the entire replacement of the species of the Douglas fir-western larch type by lodgepole pine. Within the Douglas fir-larch type, there are dry sites on which the yellow pine type occurs, and, on moist sites along streams, the cedar-hemlock type is present.

As a rule, the type is found on the upper benches and slopes of the main trenches and their tributary valleys. While glacial depressions, in which swampy conditions exclude forest growth, are present within the limits of the type, yet such swamps are not nearly so numerous as in the Douglas fir type.

CEDAR TYPES OF THE INTERIOR WET BELT

The types in which western cedar is constantly present occur in the valleys and on the lower mountain slopes of that portion of the Interior Wet belt which has an annual precipitation of 30 inches or more. In the southern portion of this belt, the cedar types occur up to altitudes of 4,000 or 4,500 feet ; in the northern portion, the range in elevation is up to 2,500 feet or 3,000 feet. Due to variations in soil and temperature conditions, three distinct cedar types may be distinguished, as follows :

Interior western cedar type
Interior western cedar-Western hemlock type
Western cedar-Engelmann spruce type

Interior Western Cedar Type

This type may be defined as one in which 60 to 100 per cent of the stand is western cedar. It occurs throughout the whole range of the cedar types and occupies sites in which the ground-water level is near the surface. It thus occurs on the secondary flood plains* along the streams, and on benches and slopes and in pockets, where the soil is constantly moist but fairly well drained. Due to normal erosive forces, the conditions that make for the favourable development of this type are changing surely though slowly, in such a way as to favour the entrance of an increasing proportion of the species of the adjoining types. Because of its value from a lumberman's viewpoint, it is an important type, some of the heaviest stands of timber in the interior being found in it. In places, groves of this type carry a stand of 100 M. board feet, or more, per acre.

Where the soil-moisture conditions are favourable, islands of this type may occur in the types adjoining it, especially in the wetter portions of the Douglas fir-larch type. In the southern portion of the province, the associates of cedar may be western white pine, western hemlock, lowland fir, western larch, Douglas fir, Engelmann spruce, alpine fir, and black cottonwood. As one proceeds northward, the lowland fir, the larch and, then, the white pine drop out of the combination, and the Engelmann spruce and alpine fir become relatively more prominent.

The rich soils of the bottom lands and lower benches of the valleys, occupied by the cedar type, offer favourable situations for ranches ; however, because of the high cost of removing the large stumps, very little of the area has been utilized thus far.

Because of its position in the moist valleys, the cedar type offers considerable resistance to extensive forest fires ; nevertheless fires have caused great damage in some localities. Whenever a crown fire occurs, owing to the thin bark of this species, nearly all the cedar trees are killed.

*By secondary flood plains are here meant those flood plains that are covered with stream water only occasionally. On the primary or recently-formed flood plains that are covered with water annually, black cottonwood is the first invading forest tree. As the flood plain is built up, western cedar and its associates encroach gradually on the cottonwood groves and eventually replace them. All stages in this development exist. (See p. 71 for a further discussion of this.)

Interior Cedar-Hemlock Type

This type is defined as one in which cedar and hemlock, combined, form 60 per cent or more of the species found in it. It is best developed on the benches and lower slopes of the valleys of the southern portion of the Interior Wet belt. The altitudinal range is between 3,000 feet and 4,000 feet elevation.

In the upper Fraser valley there are small areas where this type is present. Throughout the area which it occupies, the constant associates of cedar and hemlock are Engelmann spruce, alpine fir and Douglas fir. In the extreme southern part, the lowland fir and larch are present. White pine is an associate as far north as latitude 52° 50′ N. As previously stated, this type is encroaching on the pure cedar type, just as the cedar type encroaches on the cottonwood type. Cedar and the associated species, Douglas fir, western larch and white pine are the most valuable species in the type. The hemlock usually has a large percentage of defect and is of relatively little value.

Fires have been very destructive in the cedar-hemlock type. However, due to the moist conditions, it, like the adjoining pure cedar type, has a larger percentage of its area still in a virgin, or nearly virgin, condition than is the case in those types where the precipitation is less.

The climate of the lower elevations of the area occupied by this type is favourable to agriculture. Wherever the topography is not too rough, as on the lower benches, the soil will probably be used ultimately for farming, but at present the cost of clearing the stumps from such areas is so great as to be almost or quite prohibitive. On the other hand, because either of rough topography or severe climatic conditions, a very large proportion of the area of the type is absolute timber land. A large percentage of the timber of this type has been alienated in timber limits.

Western Cedar-Engelmann Spruce Type

The cedar-Engelmann spruce type is one in which cedar and Engelmann spruce, combined, form 60 per cent or more of the area occupied by it. It is confined principally to the Interior Wet belt. Here it is found usually on the slopes and upper portions of the side valleys of the mountains flanking the main valleys. At the south, its upper altitudinal limit is generally between 3,500-feet and 4,000-feet, but, in the northern range, it is between 2,500 and 3,000 feet.

Detached patches of the cedar-spruce type occur also in the Rocky mountains, in localities where the precipitation is 30 inches or more. Such areas are, however, too small to be indicated on the Type map.

This type, where found in the Interior Wet belt, merges imperceptibly with the cedar-hemlock type, which flanks it at lower altitudes, and with the Engelmann spruce type, which lies at higher altitudes. Western hemlock is the principal associate of the cedar and spruce. Islands of almost pure stands of hemlock may cover small areas. Douglas fir and alpine fir usually occur as associates, and white pine may also be present.

Like the other types adjacent to it, the cedar-Engelmann spruce type has not been severely damaged by fire. Except where it occurs at comparatively low altitudes, as on the lower benches of portions of the upper Fraser river, severe climatic conditions render the area covered by this type unsuitable for farming purposes. Practically none of the area is thus utilized at present.

INTERIOR HEMLOCK TYPES

Hemlock-Spruce and Hemlock-Balsam Types

Portions of the valleys of the Skeena, Nass, Unuk, Stikine and Taku rivers and of their tributaries, east of the axis of the Coast mountains, are influenced by the climate of the coast immediately adjacent to them. Consequently, their forest vegetation partakes of the nature of that of the Coastal trench. Most of that portion of the valleys whose climate is thus influenced is situated at altitudes ranging from near sea level up to 600 or 700 feet elevation. The western hemlock is the principal species of these types.

Western Hemlock-Sitka Spruce Type

This type is clearly an interior extension of the adjacent coastal plain forest. The localities in which it prevails have a precipitation ranging from 30 inches to 40 inches. The hemlock-Sitka spruce type occurs on the benches and lower slopes. It is found in Skeena valley up to a short distance below the town of Hazelton, and also in the lower course of the Zymoetz (Copper) river, a tributary of the Skeena. It occurs also some distance up the Nass river, and includes the whole of the valley of the short Unuk river. It extends up the Taku river and up the Stikine, including its tributary, the Iskut. Here, it grades imperceptibly into types characteristic of the valleys of the Yukon plateau.

The species associated with western hemlock and Sitka spruce are western cedar and black cottonwood. Indeed, on the primary flood plains,* almost pure stands of cottonwood are found, and, where soil moisture is sufficient, western cedar, more or less mixed with hemlock and Sitka spruce, forms a site type. It will be seen that this type is like that of the cedar type of the Interior Wet belt, except that Sitka spruce replaces red cedar. In the Stikine and Taku valleys, cedar is not present, but mountain hemlock is found, mixed with western hemlock. In these valleys, however, alpine fir is of infrequent occurrence, and, toward the interior limits of the type, white spruce is present.

In the Nass and Skeena valleys, a small portion of the area of this type is suitable for agricultural purpose but little of it is so utilized.

In places, the type has been badly injured by fire, but seems to be reproducing fairly well with the original species, with hemlock perhaps more abundant than any other.

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*See reference to flood plains, footnote, p. 69.

Hemlock-Engelmann Spruce Type

As the drier plateau regions of the Interior are approached in the valleys of the Nass and Skeena rivers, the hemlock-Sitka spruce type gives way to the hemlock-Englemann spruce type. The latter has been badly damaged by fire, but, for the most part, is recovering, with, however, an increased percentage of hemlock. Where repeated fires have occurred, small areas of lodgepole pine, mixed with poplar, have become established. Scattered specimens of white spruce, birch and black hemlock are found in mixture with western hemlock and Engelmann spruce and, toward the coastal limits, some western cedar. Sitka spruce and amabilis fir are found also. The upper limit of the occurrence of this type is found at about 3,000 feet altitude. Very little of the area of this type is suitable for agricultural purposes.

Hemlock-Amabilis Fir Type

Altitudinally, the position of this type is immediately above that of the hemlock-Sitka spruce type. Its lower limit is at about the 2,000-feet contour, and its upper limit is at about 3,500 feet. At the latter altitude, it merges gradually into the adjoining sub-alpine type. Besides western hemlock—which forms at least 50 per cent of the stand—and amabilis fir, with 15 to 25 per cent of the stand, there are present Sitka spruce, western cedar, black hemlock, and some Engelmann spruce. The soils of this type are wholly unsuitable for agricultural purposes.

Hemlock-Alpine Fir Type

Toward the drier interior belt, the hemlock-amabilis fir type is replaced by the hemlock-alpine fir type. The latter is situated altitudinally just above the adjacent hemlock-Engelmann spruce type, and usually lies between the 2,000 or 2,500 and the 4,000 feet contour lines. Toward the upper altitudinal limits of the type, alpine fir predominates, while, at the lower limits, western hemlock is most abundant. Engelmann spruce is found constantly throughout the type, and mountain hemlock is also present. This type grades into the Engelmann spruce-alpine fir type of the drier interior regions.

SPRUCE-ALPINE FIR TYPES OF THE INTERIOR PLATEAUS AND INTERIOR MOUNTAIN REGIONS

By far the largest proportion of that part of British Columbia which lies east of the axis of the Coast mountains is occupied by types in which Engelmann spruce or white spruce, or both, with alpine fir, combined, form 60 per cent or more of the original forest. Of such types, three are distinguished, as follows :

White spruce-alpine fir type

Engelmann spruce-alpine fir type, or lodgepole pine type

Sub-alpine type.

Photo. by C. J. Haddon
DOUGLAS FIR, RED CEDAR AND WHITE PINE, COLUMBIA VALLEY, INTERIOR WET BELT

Photo. by C. J. Haddon
RED CEDAR IN COLUMBIA VALLEY, INTERIOR WET BELT

White Spruce-Alpine Fir Type

This type occupies the valleys west of the Rocky mountains and north of about the 57th parallel of latitude. East of the Rocky mountains it evidently formed the bulk of the original forest on that portion of the Great plains which is situated in British Columbia. At the lower altitudes, alpine fir is of only scattered occurrence, but, at the higher elevations, it forms a large proportion of the stand. The type has been so badly burned that only remnants of the original forest now remain. While lodgepole pine undoubtedly formed a small percentage of the stand of the original type, repeated burnings of the forest have given it a place of much greater prominence in the present forest cover.

Over large areas, fires have been so severe as to destroy all forest growth. In some cases, such areas are practically barren, while in others they are covered with invading species of grass. This is true especially of the region of the Great plains. In this region, large areas are also occupied by bogs and swamps, in which is found a scrubby, non-merchantable growth of tamarack and black spruce. West of the Rocky mountains, areas of bog are not so extensive. Tamarack and black spruce are found in such areas along the Liard river and some of its branches, as far west as longitude 131°.*

In the Great Plains region, the remnants of the original forests on the flood plains include stands of timber, some patches of which will yield more than 10,000 board feet per acre. Here, the stand consists principally of white spruce and cottonwood. West of the Rocky mountains, remnants of the original forest average much less than 5,000 feet per acre. Near the headwaters of Stikine river, on the west slopes of the Cassiar mountains, small patches of forest are reported to contain stands, consisting of alpine fir and spruce, that will average 5,000 feet per acre.

Along Stikine river, near Telegraph Creek, semi-arid conditions prevail, especially on southern exposures, where conditions are apparently too dry to support forest growth. The area of this semi-arid region is, however, comparatively small. In the valleys of the Yukon plateau, the timber has been destroyed by fire to such an extent that a considerable proportion of the area is now occupied by dense groves of willows. Groves of pure poplar growth are also found here, especially on the better soil types, and represent the first stage in the reforestation of the areas they occupy.

With the exception of limited areas in the Peace River region, very little of the territory occupied by this type seems to have a climate favourable to agricultural pursuits. Such patches are being settled by farmers who expect to grow wheat. These lands are undoubtedly well adapted to stock-raising and to the growing of forage crops. Fairly good forage is afforded wherever severely burned areas have become covered with grass. This is supplemented by considerable areas where there is a sufficient growth of grass among the timber to support stock. Perhaps with better transportation facilities and the pressure of a larger population, the region north of the Peace River Block may

*Black spruce has been reported around Atlin lake, 134° W. long., but a search for it by one of the authors failed to confirm this report.

be settled. At Fort Liard, just north of the northern boundary of British Columbia, wheat is reported to have been grown.

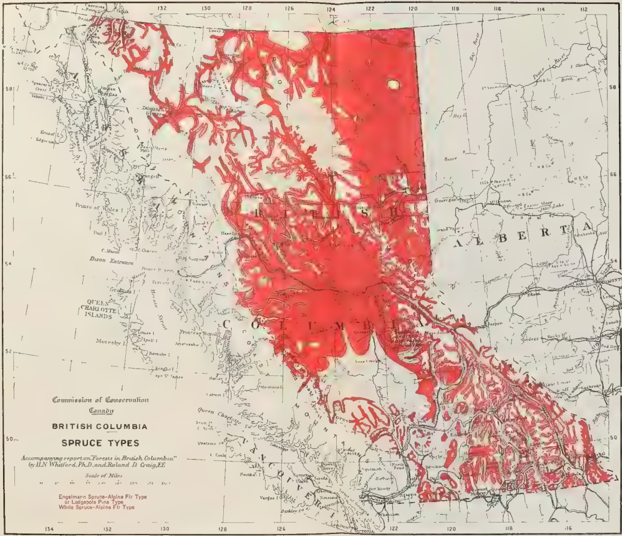
There is little chance for agricultural development in most of the vast region west of the Rocky mountains covered by this type, except as to the production of garden vegetables and forage crops. The region cannot, however, be expected to produce more than enough of garden vegetables and cattle products to supply the small local population engaged in mining, hunting and trapping. At present it is not doing even so much as this.

Engelmann Spruce-Alpine Fir Type or Lodgepole Pine Type

The original forest of the Engelmann spruce-alpine fir type is assumed to have contained 75 per cent or more of Engelmann spruce and alpine fir combined. The word 'assumed' is here used because the original forest has been so badly damaged by repeated fires that it has become extensively replaced by lodgepole pine, and it is consequently difficult to tell to what extent lodgepole pine existed in the original stand. There are areas of considerable size covered with young growth of lodgepole pine which, at present, contain little or no spruce. It is historically known that some such areas had little or no lodgepole pine on them before the original forest was destroyed by fire. For other areas now covered with lodgepole pine, there is no historical evidence nor any indication in the present vegetation that the former forest cover was anything other than lodgepole pine. Such areas usually occupy sandy, pebbly, or impoverished soils, in regions where the precipitation is light. Those who argue that the original forest on such areas was the lodgepole pine type, point to this as evidence that the conditions were never favourable to the development of spruce. On the other hand, the areas so covered with lodge polepine show the effects of repeated burnings and it is not unreasonable to suppose that such burnings have been so severe as to destroy the accumulated humus of the original forest, thus reducing its moisture-holding capacity and rendering conditions unfavourable for the re-entrance of the species of the original forest. Be that as it may, the fact remains that on such areas the lodgepole pine type must now be considered as the permanent type for purposes of management.

With the exception of the white spruce-alpine fir type, the climatic conditions of the Engelmann spruce-alpine fir type are colder than those of any of the other merchantable types. This follows logically from the fact that these types occupy the highest latitudes and altitudes of the interior of the province. The moisture conditions are, however, variable, depending on the climatic belt in which the portion of the type under consideration is situated.

In the southern third of the province the Engelmann spruce-alpine fir type occupies a region that lies between approximately the 3,500 to 4,000 and the 5,000 to 6,000-feet contour lines. At the lower altitudes, Engelmann spruce forms the largest percentage of the stand. As the higher altitudes of the type are approached, alpine fir becomes more and more prominent. At the tension zone between the type and those lying immediately adjacent and below it, there is a mixture of the species of the latter types. Thus, in the



Base map from plate of Map of Dominion of Canada, Dept. of Interior.

Southern Interior plateau, Douglas fir forms a small percentage of the stand of the type. Again, where the type borders on the Douglas fir-larch type, Douglas fir, larch and western white pine may be present in it. In the Interior Wet belt, one or more of the species of cedar, hemlock, white pine and Douglas fir may occur in the mixture.

Where the type occurs as a zone or belt on the slopes of the mountains and in the upper reaches of the valleys, it is in places badly cut into strips by avalanches and snow slides. Such destructive forces reduce the area occupied by the type and decrease its productive value. In some cases, slides extend to such low altitudes that the forest destruction is carried into the types of the lower elevations, thus lessening the actual stands of timber in them also. In the Selkirk, Monashee and Rocky mountains, especially that portion of them where the precipitation is heavy, the aggregate of forests destroyed by the unstability of the soil is very considerable ; yet where the strips of timber, alternating with these mountain-side 'scars,' have been little or not at all damaged by fire, the reforestation of the scars is fairly rapid, and all stages in this development can usually be traced in any high mountain valley. In this way, as the 'slides' become more and more stable, they eventually become reclothed with the original forest vegetation.

On the slopes of valleys where fires have destroyed or partially destroyed the original forest, the land and snow slides are much more frequent. Consequently, the area that, normally, would have a forest growth is much more reduced, and, even if protected from fire, its recovery is much slower. Thus, in such cases, the final forest crop tends strongly toward a change from the original type to the lodgepole pine type.

The portion of the Engelmann spruce-alpine fir type in the central third of the province, east of the Coast mountains, and comprising the northern half of the Interior plateau, a portion of the Cassiar system, and the neighbouring mountains, lies at an average altitude that is much lower than that of the area occupied by the same type in the southern third of the province. In the central region, the type is found from the lowest altitudes (1,000 to 2,000 feet) of the area up to 4,000 feet and, in some places, 5,000 feet. Since most of the area of the plateau lies below the 4,000-feet contour, the type spreads out over most of its surface, and only in the neighbouring mountain regions does it merge into the sub-alpine types. At the lower altitudes, alpine fir is absent or of only scattering occurrence, but, at the higher altitudes, it is much more abundant and may form as high as 50 per cent of the stand.

The precipitation of the area occupied by the central portion of the type is usually less than that of the type area in the southern third of the province. With the exception of the white spruce-alpine fir and the Interior Douglas fir types, no other type in the province has suffered so much from damage by fire as the Engelmann spruce-alpine fir type. As a result, the lodgepole pine has made great inroads, and the area in which this tree predominates is probably greater than that on which the spruce occurs.

Glacial depressions occur throughout the plateau portion of the type. The deepest of these are filled by long, narrow lakes, which represent the

broadened-out portions of the drainage lines. The levels of the largest of these lakes vary in altitude from 2,200 feet at Stuart lake to 2,978 feet at Eutsuk lake. Numerous small lakes, many of them still unmapped, dot the uplands and the valleys of the plateau. Numerous depressions that formerly existed as lakes have since been wholly or partially drained as a result of action by the normal erosive forces. Depending on the amount of soil moisture, such depressions show different stages of development toward the climatic forest type of the region. In some cases, only the last vestige of the lake remains, with zones of wet meadows around it, in which are found scattered individuals of black spruce, alder and willow. In other cases, the meadow stage covers the entire depression, with a zone of the same species on the drier though still moist soils. In still others, Engelmann spruce and alpine fir are encroaching on the black spruce zone. There is evidence to show that many areas now covered with the Engelmann spruce-alpine fir type were formerly old lake bottoms. In some instances, the erosive forces have entirely obliterated the lakes ; in others, a chain of small lakes still remains in a single drainage line, connected with each other by different units of the same stream. The drainage of many of these lakes has been prevented by the presence of beaver dams.

With the confluence of the Stuart and Nechako rivers as a centre, and radiating in all directions to a distance varying from 75 to 100 miles, is an area in which, especially at the lower elevations, Douglas fir occurs in mixture with the leading members of the Engelmann spruce-alpine fir type. On special sites within this area, where the soil is fairly rich and drainage conditions are medium, there are patches of fairly heavy stands in which Douglas fir forms 50 per cent or more of the mixture. All the evidence indicates that, throughout this region, Douglas fir existed originally to a much greater extent than at present. In some places, single specimens of large Douglas fir trees, scarred by fires, are scattered throughout the forest. In others, only large charred stumps of Douglas fir remain. There is evidence to show that, within the limits of the area described at the beginning of this paragraph, there existed originally a distinct climatic type which could be designated the Engelmann spruce-Douglas fir type. This type, if it did exist, was closely related to the Douglas fir type which occupies the physiologically drier areas that lie in the Interior plateau to the south of it.

In admixture with the species of the Engelmann spruce-alpine fir type are found hemlock and cedar, which are species of the types of the Interior Wet belt ; there are also included in the mixture, species of the types which occur in the moister regions of the Skeena system, adjacent to the Engelmann spruce-alpine fir type. Thus, near the western edge of the latter type, islands occur, in which western hemlock and western cedar form a considerable percentage of the mixture. Such islands occur also around the lakes at the eastern base of the Coast mountains and, in places, in the Rocher Déboulé and Babine ranges.

Where fires have succeeded in destroying all, or nearly all, of the original vegetation, as is the case over small patches scattered throughout the drier

portions of the northern part of the type, the soil thus exposed is either almost destitute of vegetation or is partly or wholly covered with grass. Such areas will gradually become reforested unless prevented from doing so by continued future burnings. Groves of aspen, with or without western birch, represent the first stage in the reforestation of areas that have been burned over. This is true especially on the richer soils. On poorer soils, lodgepole pine, with aspen and western birch, are the first invading species. Usually, however, Engelmann spruce invades these areas sooner or later, and, eventually, replaces the faster growing but shorter-lived species that first occupied the ground. Depending upon the extent of destruction of the virgin forest by fire, all sorts of mixtures of the foregoing species occur. If the fires have been light, recovery is rapid, and takes place in one or two generations. If severe, a large number of generations may be required to complete the recovery. As already stated, much of the region may never be allowed to recover its former condition, simply because the temporary forest types may be the *managerial* ones ; or, where the soil conditions are favourable, the ground may be used for agriculture or for grazing.

An attempt has been made to show on the Stand Type map the areas within which agricultural pursuits may prove practicable. If grazing land were included, these areas could be considerably enlarged. Some of the land situated within these areas cannot be profitably cultivated, because of either rough topography or poor soil conditions. Even if all of the area classified as agricultural should eventually be brought under cultivation, it would represent but a very small proportion of the entire area covered by this forest type. At present, very little of it is being farmed. The products obtained are vegetables, root crops, forage crops and hardy grains. In the Bulkley valley, stock-raising is the principal industry. Some of the wet meadows furnish natural forage crops, and more or less grazing is also available in the semi-open timber lands, where peavine and other forage plants occur. It is believed that, in the long run, the region is best suited to dairy farming. At any rate, the climatic conditions are not dissimilar to those of northern Europe, where dairy farming is the principal agricultural industry.

The Sub-alpine Forest Types

Reference to Land Classification table in Chapter I, Part II, will show that approximately 39 per cent of the area of the interior of British Columbia is situated above the merchantable timber line, that is, the line above which the climatic conditions are too severe for commercial timber to be produced. The altitude of this line varies in different parts of the province. For the southern third of the province, its average elevation is between 5,000 feet and 6,000 feet above sea level ; for the central third it lies between the 4,000 and 5,000-feet contours ; and for the northern third it is between 3,000 feet and 4,000 feet altitude.

The *cold timber-line*, that is, the line beyond which, because of severe climatic conditions, tree growth is entirely absent, is from 800 to 1,200 feet above the *merchantable timber-line*. It is in the belt between the merchantable

timber-line and the cold timber-line that the sub-alpine type of forest lies. The composition of this type varies according to the latitude and the degree of moisture present.

Our knowledge of the distribution of the alpine trees of the province is still incomplete. Alpine fir seems to be the only tree species that is distributed throughout the entire area of the type in the interior of the province. It occurs from the international boundary on the south to the Alaska and Yukon boundary on the north. This species is usually found from the merchantable timber line, and below it, up to the highest altitudes that tree species will grow. Engelmann spruce is an associate of alpine fir from the southern boundary of the province north to about latitude 57°. However, it does not reach as high altitudes as does alpine fir.

White-bark pine is confined to the mountains of the southern half of the province. It occurs in the Rocky mountains as far north as the headwaters of Parsnip river (lat. 54° 30′ N.). It occurs throughout the Selkirk and Monashee mountains and in the Coast mountains as far north as the headwaters of the Nechako river (lat. 53° 40′ N.). Toward the south it is usually an associate of alpine fir from the merchantable timber-line to the cold timber-line. In places, it is found scattered at somewhat lower altitudes, as an associate in the upper portions of the Engelmann spruce-alpine fir type.

Alpine larch usually occurs in portions of the higher limits of the sub-alpine type in the southern part of the province. In the Rocky mountains it is known to occur as far north as Kicking Horse pass, or about lat. 51° 30′ N. It is also reported in the Selkirk mountains, from the southern boundary of the province to the latitude of the north end of Kootenay lake. It has also been reported on the west slopes of the Cascades in the Skagit valley.

Mountain hemlock, in the interior, is confined to the moistest regions of the interior mountain ranges, mainly on the west slopes of the Selkirk mountains, and probably also in portions of the Monashee mountains. It occurs also on the west slopes of the Coast mountains south to the international boundary, and in portions of the west slopes of the mountains of the Cassiar system.

Lodgepole pine occurs in many places throughout the area of the interior sub-alpine type, but only at the lower altitudinal limits of this type.

The sub-alpine type is not a closed forest type, except in places where it borders on the Engelmann spruce-alpine fir type below. It is characterized rather by scattered single trees or groups that have found lodgment where conditions for tree growth are most favourable. The very open nature of the type can not be ascribed entirely to the extreme cold conditions of the habitat but chiefly to the roughness of the topography and the instability of the soil, or to the presence of snowfields which, in sheltered places, remain too late in the season to permit the establishment of tree growth.

Landslides and snowslides are frequent at these high altitudes. Some of them originate in the sub-alpine zone, and others in the alpine zone above it. In addition, the effect often extends not only through the area of the sub-

alpine type, but in many cases, the disturbances are so frequent as to prevent the invasion of forest growth in the types below where such slides occur. In many ravines, on protected slopes, and in glacial cirques, snow accumulates to such a depth that it remains throughout the summer months or disappears for only a short period. In the latter case, while the conditions are favourable for the rich perennial herbaceous vegetation which forms the mountain meadows, there is too much moisture for tree growth.

Thus, the sub-alpine zone presents a picture of strips or groves of scrubby forest, alternating with stretches of rock waste, with scattered trees here and there, or with islands of mountain meadows.

In many instances, however, the area disturbed by land-slips or by snow-slides comes ultimately to a position of greater stability. In such cases, there is a gradual encroachment of vegetation, and, eventually, if the area is not further disturbed, the forest will establish itself.

While the forests of the sub-alpine zone may have some commercial value in furnishing mining timbers or fuel to prospectors, hunters and travellers, their chief value consists in their function of preventing the rapid melting of the snow and thus minimizing the danger of destructive spring floods. There is no doubt that if the forest growth of this zone were destroyed by fire, as it has been in some regions, the destructiveness of annual floods in the lowlands would be much greater than at present.

The mountain meadows have a potential value for mid-summer grazing, especially when they are adjacent to regions where stock raising is well developed. At present, such meadows are utilized in this way to only a very slight extent.

SUMMARY

1. The province of British Columbia contains a series of climatic belts paralleling the coast. These belts correspond in a general way to the physical features of the country, and differ from each other mainly as to moisture conditions.

2. Within these belts, due to altitudinal and latitudinal variations, there are climatic regions, which differ from each other in heat and moisture relations.

3. The climatic regions support distinct classes of forest growth that can be called *climatic types of forest.*

4. Within these climatic types, due mainly to variations in soil-moisture contents, or to disturbance of the original forest by fires, there are local areas that contain types of vegetation different from the climatic types. Because there is a tendency for these types, in their development, to converge toward the main type of the region, they may be called *temporary types*.

5. In many instances, the processes of recovery are so slow that the temporary types must, from the viewpoint of forest management, be considered more or less permanent ; for this reason, they may be considered as *managerial types*.

CHAPTER IV

Land Tenure in British Columbia

THE land tenure system in British Columbia, especially in regard to timber-land, is complicated, owing to part of the land being administered by the Dominion Government and part by the Provincial. Under the terms of union, British Columbia, in 1871, ceded to the Dominion, as its contribution toward the building of the Canadian Pacific Ry., a strip of land, known as the Railway Belt, extending twenty miles on each side of the railway from the eastern boundary of the province to the head of Burrard inlet, and comprising approximately 10,976,000 acres ; also the Peace River Block, 3,468,000 acres, in the Peace River district, transferred in lieu of lands in the Belt alienated by the Province prior to the transfer. The Dominion also controls 50,000 acres of coal land in the Crowsnest district, making a total of 14,494,000 acres of Dominion land in British Columbia. The remainder, aggregating approximately 211,700,000 acres, is under provincial control.

As the various forms of tenure are not generally understood, the salient features of each, with reference to forest administration, will be given here. The term 'land' in this connection will be used in its broader sense to include the timber, minerals and other natural resources pertaining thereto. A classification of these forms of tenure, and their relationship to the forest administration, follows :

PROVINCIAL LANDS

Crown-granted or permanently alienated lands—

Grants in aid of railways, roads, dyking and other public works.

Lands sold :

(a) Prior to April, 1887.
(b) Between April 7, 1887, and March 12, 1906.
(c) Subsequent to March 12, 1906, and previous to March 1, 1914.
(d) Sold since March 1, 1914.

Lands homesteaded or pre-empted.
Mining Claims.

Crown Lands—

(1) Temporarily alienated.
Timber leases.
Timber licenses.
Hand-loggers' licenses.
Timber sales.

Plate XI

Photo. by Forest Branch

SAWMILL, SPRUCE CREEK, ATLIN, B. C. YUKON PLATEAU

Photo. by Forest Branch

SPRUCE LOGS, McKEE CREEK, ATLIN, B. C. YUKON PLATEAU

(2) Unalienated.
 Forest reserves.
 Provincial parks and game reserves.
 Lands available for disposition.

Dominion Lands

Crown-granted lands—

Lands sold.
Lands pre-empted or homesteaded.
Mining claims.

Crown Lands—

(1) Temporarily alienated.
 Lands leased for coal, petroleum, mining, quarrying, grazing, etc.
 Timber berths.
 Timber permits.

(2) Unalienated.
 Forest reserves.
 Dominion parks.
 Lands available for disposition.

Indian Reserves.

Provincial Lands

To understand the present status of the various forms of tenure under which the forest lands of British Columbia are classified, it is necessary to review, briefly, the history and development of the systems of alienation adopted during the different periods of provincial history.

The earliest system of land disposal, by Crown grant, or deed, carried the rights to all the natural resources appurtenant to the land. In 1870, however, the system of granting the right to cut timber under leases distinct from the ownership of the land was introduced. The advantages of this distinctively Canadian system were easily recognized, and, as a result, the province has retained an interest in and a control over by far the greater part of its forest resources ; at the same time it has supplied the lumber industry with abundant raw material at a reasonable price.

The evolution of the forest land administration has not been accomplished without mistakes, but it can be stated with confidence that the forest legislation now in force in British Columbia is, in many respects, the most efficient and progressive on the continent.

CROWN-GRANTED LANDS

A statement furnished by the Dept. of Lands gives the approximate area of land permanently alienated by the province at 16,417,175 acres. Of this amount, 12,278,841 acres has been Crown-granted through sale or pre-emption, and 4,138,334 acres has been granted in aid of railway construction.

Railway Grants

The original grants to railways amounted to 8,203,410 acres, but 4,065,076 acres were subsequently repurchased from the Columbia and Western and British Columbia Southern railways.* The railway grants were :

Nelson and Fort Sheppard Ry	550,783	acres.
British Columbia Southern Ry	3,755,733	"
Columbia and Western Ry	1,348,225	"
Kaslo and Slocan Ry	250,022	"
Columbia and Kootenay Ry	188,593	"
Esquimalt and Nanaimo Ry	2,110,054	"
	8,203,410	acres.

Areas Granted or Applied for

The following statement, furnished by the Minister of Lands, shows the disposition made of provincial lands from 1905 to 1916, inclusive :

	Acres	
Crown-granted—		
Grants to railways	564,863	
Purchased	1,974,177	
Pre-empted	782,627	
Mineral claims	158,447	
Miscellaneous	103,768	
		3,583,882
Pending Applications to Purchase—		
Surveyed	2,291,803	
Unsurveyed	418,311	
		2,710,114
Pending pre-emptions		3,608,475
Total, acres		9,902,471

Crown-Granted Timber Lands

Though most of the land which has been Crown-granted is potential forest land, only a relatively small amount is classified as statutory timber-land. In 1915, only 913,245 acres were assessed as such. A careful examination of these lands would show that a very much larger area should be so classified.

Lands Sold—In the early days, the standing timber was considered of no great value, and, in spite of the provision of the Land Act, 1884, that "no land chiefly valuable for timber shall be disposed of by public or private sale," until as late as 1896, land "suitable for lumbering" was classified as first-class land and sold as such. Prior to 1888, the general price of land, including timber, coal and base metals, was $1 per acre.

From April 7, 1887, to April 28, 1888, the land sold was called 'patented land,' and the applicant had to make a declaration before a justice of the peace that the land was not chiefly valuable for timber before his application was granted. The owners of patented lands, as well as pre-emptors who had not proved up, required licenses to cut timber on their land, for other than domestic or farm use or than for clearing and improvement of their lands. Such licenses, allowing them to cut for the manufacture of lumber, could be secured for 25 cents per thousand board feet for the amount of timber applied for.

* The area repurchased from the British Columbia Southern and the Columbia and Western railways includes 583,047 acres, in which the Heinze estate owns an undivided one-half interest.

In 1888, a comprehensive Land Act was passed, respecting the sale, leasing and licensing of Crown Lands. Under this Act, the land was classified and sold as follows :

> All unsurveyed lands could be purchased at a price of $2.50 per acre ; they had to be surveyed and full payment made within six months after the date of application.
>
> Surveyed lands were divided into two classes ; the first class, consisting of land suitable for cultivation or lumbering and natural hay meadows, was offered at $2.50 per acre, and the second class, mountainous tracts of land not suitable for cultivation, and valueless for lumbering purposes, at $1 per acre.
>
> Each purchaser was limited to one lot of from 160 acres to 640 acres, and a royalty of 50 cents per M. was reserved on all timber from lands sold subsequent to April 28, 1888, and also from 'patented' lands granted after April 7, 1887.

In 1891, the Land Act required the survey and the classification of the land by the surveyor before purchase, as follows :

> *First Class*—Land which can be brought under cultivation profitably, or which contains timber suitable for lumbering purposes (5 M. per acre on each 160 acres), or wild hay or meadow-land. Price $5 per acre.
>
> *Second Class*—Land requiring drainage or irrigation, and not carrying merchantable timber as defined above. Price $2.50 per acre.
>
> *Third Class*—Mountain and rocky land, without merchantable timber. Price $1 per acre.

Purchasers were limited to from 160 to 640 acres each, and a second purchase could not be made until the first had been improved to an extent equal in value to the original price of the land.

This was the first attempt to define timber-land, and it will be seen that the objects sought were, by limiting the area to be purchased and, by imposing improvement requirements, to promote agricultural development, and to limit the sale of timber.

In 1896, timber-land was more explicitly defined as land carrying 8,000 feet, board measure, per acre, when situated west of the summit of the Cascade range,* and 5,000 feet per acre, when east of the summit. This is still the statutory definition of timber-land in British Columbia. Such land was at that time excluded from the classification of first-class land and was reserved from sale, but, owing to the lack of inspection, the Act was very liberally interpreted in most cases.

A ruling was made, in 1901, that royalty should not be considered as taxation in connection with railway lands, and that such lands previously granted should be subject to the royalty of 50 cents per M.

In 1903, owners of patented lands were relieved of the necessity of obtaining a license to cut timber on their lands, and the royalty was increased from 25 cents to 50 cents per M. b.f.

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*The Cascade mountains were then, and are still, considered in legal descriptions to also include the Coast mountains, which is the name applied to the mountains bordering the Pacific mainland coast and lying north and west of the Fraser river.

At this time also, a tax according to the following schedule was imposed on all timber cut from lands on which a royalty was not reserved, that is, lands Crown-granted prior to April 7, 1887. However, all of this tax, except one cent per M., was rebated, if the timber was manufactured in the province, so that it was in reality an export tax on raw material.

SCHEDULE No. 1

(Spars and saw-logs and saw-bolts of all kinds)

Length in feet	Diameters in inches	Rate per M. feet on grade			Additional rate for increased sizes				
					Diameters		Grade		
		No. 1	No. 2	No. 3	Not under	Not over	No. 1	No. 2	No. 3
Not over	Not over				Inches	Inches			
40	24	$2.00	$1.50	$1.00	25	31	$0.20	$0.15	$0.10
50	24	2.25	1.75	1.25	32	36	0.40	0.30	0.20
60	24	2.50	2.00	1.50	37	41	0.60	0.45	0.30
70	24	2.75	2.25	1.75	42	45	0.80	0.60	0.40
80	24	3.00	2.50	2.00	46	48	1.00	0.75	0.50
over 80	24	4.00	3.00	2.50	over 48	..	1.50	1.00	0.75

A rebate of all the tax over and above one cent per M. feet, board measure, shall be allowed, when the timber upon which it is due or payable is manufactured or used in the Province of British Columbia.

SCHEDULE No. 2

(Piles, poles and crib timbers)

Lumber, in feet.	Diameter, in inches.	Rates per lineal foot	Piles or poles over 12 inches dia. shall be scaled, graded No. 1, and taxed at rates as under.	
Not over	Not over		Length	Per M. b.m.
40	11	$0.01	40	$2.00
50	11	0.01¼	50	2.25
60	11	0.01½	60	2.50
70	11	0.01¾	70	2.75
80	11	0.02	80	3.00
over 80	11	0.02½	over 80	4.00

A rebate of all the tax over and above 5 cents per 1,000 lineal feet shall be allowed, when the timber upon which it is due or payable is manufactured or used in the Province of British Columbia.

Provided, always that the Lieutenant-Governor in council may allow such rebate on piles, telegraph poles and crib timber not manufactured or used in the province, as may be deemed advisable.

SCHEDULE No. 3

Mining props and logging....................................50 cents per cord
Railway ties..50 cents per cord
Cordwood..25 cents per cord

A rebate will be allowed of all the tax over and above one cent per cord on all railway ties, mine props, and logging and cordwood used in the province.

SCHEDULE No. 4

Shingle or other bolts of cedar, fir or spruce, $1 per cord. The rebate to be allowed when manufactured or used in the province of British Columbia shall be all over and above one cent per cord.

The attitude of the Government toward the conservation of timber was shown by the classification of land for taxation purposes in 1905, which provided for taxes amounting to 4 per cent of the assessed value of wild land, that is, unimproved land carrying less than 5 M. per acre, and only 2 per cent on land carrying more than 5 M. per acre.

In 1906 the third class was eliminated from the classification of land for purchase, leaving only the first and second classes, for which $5 per acre and $2.50 per acre, respectively, was charged. These classes were as follows :

"Lands which are suitable for agricultural purposes or which are capable of being brought under cultivation profitably, or which are wild hay-meadow lands, shall rank and be classified as first-class lands. All other lands, other than timber-lands—shall rank and be classified as second-class lands. Timber lands (that is, lands which contain milling timber to the average extent of 8 M. feet to the acre west of the Cascades, and 5 M. feet per acre east of the Cascades, to each 160 acres), shall not be open for sale."

The sale price of land was increased, in 1912, to $10 per acre for the first-class land, and to $5 for second-class, and the exportation of logs from lands granted subsequent to March 12, 1906, was prohibited.

By an amendment to the Forest Act in 1914, the old schedules of export taxes on logs cut from Crown-grant land were replaced by the following : No. 1 grade logs, $2 per M.; No. 2 grade logs, $1.50 per M.; No. 3 grade logs, $1 per M.

In 1915, the royalty on timber cut on lands on the coast, granted subsequent to March 1, 1914, was increased to 85 cents for the upper grades and subjected to the same conditions in that connection as licenses. Practically all the unalienated Crown lands are now withdrawn from sale and are reserved for pre-emption or for forest purposes.

Lands granted in aid of railways or other public works, for the most part, come under the regulations governing other lands granted at the same time.

The present conditions pertaining to Crown-granted timber-lands are therefore as follows :

All Crown-granted timber-lands, except railway lands exempted, are subject to the timber-land tax of 2 per cent of assessed valuation, and all are assessed 1½ cents per acre for the forest protection fund.

Lands granted prior to April 7, 1887, are not subject to a royalty on the timber, if manufactured in the province, but, if exported, the tax provided for in the schedule previously quoted applies.

All lands granted subsequent to April 7, 1887, and prior to March 12, 1906, including patented lands, are subject to a royalty of 50 cents per M. on the timber cut therefrom, and the logs cut from these lands may be exported without the payment of the export tax. Lands granted subsequent to March 12, 1906, and prior to March 1, 1914, are subject to a royalty of 50 cents, and the logs cut therefrom are not exportable. Timber cut from lands granted since the latter date is subject to the same royalty as licenses, and the timber must be manufactured in the province.

The status of the lands included in the Esquimalt and Nanaimo Ry. land grant has been the subject of much discussion, and a final decision has not yet

been reached. No royalty is collected at present for the timber cut from these lands, and the logs may be exported on the payment of the export tax.

Pre-empted Lands—Practically the same regulations in regard to the timber on lands sold applies also to pre-empted lands. Settlers are not now allowed to take up land carrying merchantable timber, and most of that which had been previously so secured, was granted without proper inspection. Settlement on lands covered by timber leases or licenses has not been permitted for many years, and, even when such was permitted, the pre-emptor secured no right to the timber. The problem of fraudulent homesteading, therefore, which is so serious in some timbered regions, has never been of much concern in this province.

Mining Claims

Under the Mineral Act, mining claims may be located by any person over 18 years of age, or by any joint stock company, possessing a miner's certificate, upon any waste land of the Crown, except land occupied by buildings, Indian or naval reserves. The holder of a mineral claim may use the surface and timber rights for mining purposes, but all remaining rights are vested in the Crown.

CROWN LANDS

Timber Leases

Leases for the purpose of cutting timber were first granted in 1870. Until 1888, these leases were granted for any area of unpre-empted and unsurveyed land, for the purpose of cutting spars, timber or lumber, to any person or corporation actually engaged in such pursuits, subject to such rent, terms and provisions as seemed expedient to the Lieutenant-Governor in council. The rental varied from five to ten cents per acre per annum, and the royalty was 20 or 25 cents per M. feet. In 1888, the rental on these leases was fixed by the Land Act at five cents per acre on all those granted since 1879 and previous to the passing of this Act. Though these early leases were renewable indefinitely, very few are now in force.

Thirty-Year Leases

In 1888, further legislation authorized the granting of leases for a term not exceeding 30 years, at a fixed annual rental of 10 cents per acre and a royalty of 50 cents per M. This royalty was also imposed on all leases granted subsequent to 1879. A rebate of 25 cents per M. was, however, allowed for all spars, piles, shingles and manufactured lumber exported to points outside the province. This export rebate was allowed on lumber, spars and piles till 1900, and on shingles till 1905. As a condition of the timber lease, the operation of a saw-mill with a capacity of 1,000 b.f. per day of twelve hours, for each 400 acres held under lease, was required.

Hemlock Bark Leases

In 1891, 30-year leases were granted for cutting hemlock bark for tanning purposes, on such special terms as the Government conceded. This legislation was not taken advantage of until 1905-06, when 32,252 acres were leased at a rental of two cents per acre for the first five years and five cents per acre thereafter. The granting of the leases

SPRUCE ALONG FORT NELSON RIVER, GREAT PLAINS REGION

COTTONWOOD AND SPRUCE, NEAR FORT NELSON RIVER, GREAT PLAINS REGION

was conditional upon the operation of a tannery. Most of these leases are still in force, but some have been converted into special timber licenses.

Manufactured in Province

In the same year (1891) a law was passed requiring all timber cut from land held on leases, licenses or hand loggers' licenses, to be manufactured in the province. This policy has been followed ever since, except during a few periods when it was deemed in the public interest to raise the embargo.

Bonus System

In 1892, the bonus system was inaugurated, and leases were granted to the tenderer offering the highest cash bonus, but, owing, perhaps, to the abundance of available timber, this system was not generally followed. The same conditions were attached to these leases as formerly, except that, upon the deposit of 10 cents per acre being made, in addition to the rental, the lessee was allowed two years to build his mill.

Twenty-one-year Leases

In 1895, the term for which the leases could be granted was reduced to 21 years, and the rental increased to 15 cents per acre. The operation of a saw-mill was still required.

In 1897, the necessity of having a saw-mill was not insisted on, but the rental was reduced to 10 cents per acre for those who did operate mills. In 1898, another change was made, authorizing the granting of leases for 21 years, at a rental of 15 cents per acre per annum and a royalty of 50 cents per M., provided that, if the rental and royalty together did not in one year equal 50 cents per acre, the lessee must make up the difference. He was required also to operate a mill having a 12-hour capacity of 1,000 feet for every 100 acres of lease, for six months a year, unless excused by the Government.

In 1901, the Land Act provided also for the renewal of the ordinary 21-year leases for consecutive and successive periods of 21 years, subject to the then existing conditions, regulations, royalties and rentals. Provision was also made for all the old leases (30-year) to come under this ruling, if surrendered within one year. At the same time, it was provided that the original terms as to royalty, rental, etc., should apply for the unexpired period of the lease to be surrendered ; after the expiration of such period, the terms were to be the same as in the 21-year leases.

The granting of all timber leases was discontinued in 1906, the last few being granted at a rental of 25 cents per acre.

Pulp Leases

In 1901, the first demand for pulp leases was made, and the Government made provision for the withdrawal of certain areas from which the leases were to be selected within two years. These leases were originally granted for 21 years, at an annual rental of 2 cents per acre. A royalty, not exceeding 25 cents per cord of pulpwood, was imposed. These leases were renewable for consecutive periods of 21 years, on such conditions as might be in force at the termination of the period, or be determined by the Government. Under the terms of the lease, the lessee was required to build a pulp-mill in the province, with a capacity of one ton of pulp or one-half ton of paper per day for each square mile of land included in the lease, and to operate it within such time as might be fixed by the Govern-

ment, at least six months a year. Timber not used for pulp was subject to the same royalty as that from licenses and timber leases (50 cents per M.). All the timber cut from pulp leases was required to be manufactured in the province. This law was repealed in 1903, after 353,250 acres had been so granted. Later, the Forest Act of 1912 provided for the disposal of pulp licenses as timber sales.

Increase in Rental and Royalty

The Forest Act, 1912, provided for the increase in rental and royalty on all leases which had been renewed under the provisions of 1901 (old 30-year unrenewable leases) to the equivalent of that collected on licensed lands, *viz.*, approximately 22 cents per acre rental and 50 cents per M royalty, and it provided also for the surrender and exchange of these leases for special licenses covering the ground. The Timber Royalty Act, 1914, increased the royalty on all leased timber to 85 cents per M. feet for the upper grades, the same as that cut under license, except that the 21-year renewable leases are not affected until the current leases expire. Renewals of these leases will be granted in the same manner as ordinary timber licenses.

Areas under Lease

The areas of forest land held under the three forms of leases, at the end of 1916, were as follows :

Timber leases	572,774 acres
Hemlock leases	32,169 "
Pulp leases	353,250 "
Total	958,193 acres

To the foregoing, there should be added 114,927 acres originally held under timber leases which have been renewed as timber licenses, making a total of 1,063,120 acres which has been alienated in this manner. A considerable area once held under lease has reverted to the Crown after being logged.

Timber Licenses

About three-quarters of the alienated timber lands is held under timber licenses. The license system originated in the old 'general' license, which was designed to supply with timber the small independent logging operators who could not afford to own saw-mills, as was required by the timber leases. The original conditions pertaining to these licenses have been so changed that they now confer what is, in at least some important respects, the most secure, and at the same time the most equitable, timber title that any government in the United States or Canada grants.

General Licenses

The first general licenses were granted in 1884, and were limited to 1,000 acres to one person, and the term of tenure was four years. The annual rental was $10. The licensee had to keep account of the number of trees cut (not including small trees cut for skids, levers, rafting stuff or the like), and pay a royalty of 15 cents per tree, and in addition, 25 cents per M. on the timber cut. The license was not transferable, and could be cancelled, if the timber was not operated.

Special Licenses

In 1888, the Land Act provided for the granting of 'special' licenses to cut timber on areas up to 1,000 acres for one year only, renewable at the discretion of the Chief Commissioner of Lands and Works. They were not transferable, and each individual was limited to one license. The rental was increased to $50 per license, with a royalty of 50 cents per M., one-half of which was rebated if the lumber were exported out of the province.

In 1894, provision was made for the staking of lands for licenses. In 1901, the area granted under the licenses was reduced to 640 acres (80 x 80 chains or 40 x 160 chains). They were still granted for one year only, and were not transferable, but a person could hold two at one time and the fee for each was increased to $100. At this time, also, a law was passed requiring the manufacture within the province of all timber cut from leases and licenses.

In 1903, the license fees were further increased to $140 each on lands situated west of the Cascades, but, owing to the lighter stands in the interior, they were left at $100 for licenses east of the Cascades. Provision was made for a longer tenure by allowing the licensee to pay the fees in advance up to five years, after which, renewal could be secured only at the discretion of the Chief Commissioner of Lands and Works, and upon such terms as were then in force.

It will be seen that, up to this time, the whole trend of the legislation had been to dispose of timber only to operators, and only as required for cutting. With the growth of the lumber industry, more stable conditions as to the supply of timber became desirable, in order that the necessary financial support could be secured. It was found advisable, therefore, to extend the term of tenure and to allow the sale or transfer of licenses. Previous to this, those who operated under licenses were at a great disadvantage as compared with owners of Crown-granted timber-lands or leases, as, in the former case, the supply of timber was not assured, and operators were thus deprived of one of the chief assets of a lumber business. In 1905, therefore, the then existing licenses were extended to 16 years ; they were made transferable but the royalty was increased to 60 cents per M. At the same time, legislation was passed permitting the granting in the future of transferable licenses renewable for 21 years. The annual license fee remained at $140 per square mile west of the Cascades, but was increased to $115 east of the Cascades, and royalty on all licenses was 50 cents per M. The Government reserved the right to revise either the rental or royalty at any time by act of the legislature. The land held under license was required to be surveyed before cutting was commenced, which had not previously been necessary.

Staking Licenses

To secure a special license, a stake, bearing a notice of intention to apply for a license covering a described area, not exceeding 640 acres, was planted at one corner of the claim, and a copy of the notice was advertised for two months in the *British Columbia Gazette* and a local newspaper, after which, application was made to the Government and the first license fee tendered. If acceptable, and no conflict of boundaries was apparent, the Commissioner of Lands and Works issued a license to cut

timber on the area described, for one year, with the privilege of renewal for twenty successive years, upon the payment of the required license fee or rental, in advance. No bonus was required, but provision was made that, if competition for the lands developed, the Government might call for bids.

Coming at a time when speculation was rife in land and timber, and when the conservation propaganda in the United States was calling attention to the failing timber supplies in that country, this legislation, permitting the acquiring of timber with such small initial expense, resulted in a real timber boom, and the number of licenses increased from 1,451 in 1904 to over 15,000 in 1907. Including the cost of locating, which probably averaged $50 per license, and advertising, about $15, the average claim cost the stakers about $205 on the coast and $180 in the interior. This gave them the right to cut anywhere from 5,000,000 to 40,000,000 feet, depending on the timber staked. By the end of 1907, there was little accessible timber not staked and much, with slight prospect of ever being exploited by means then known, had been taken up. As surveys were not required, except as the land was to be logged, much confusion has resulted from the overlapping of claims, and considerable additional revenue has accrued to the Government as a result. As one example of what has happened, the case may be cited of six different licensees who, for several years, paid fees on the same block of 400 acres of timber. The failure of many licensees to locate their limits accurately also resulted in the unnecessary inclusion of non-timbered lands, such as burns, areas above timber-line, etc., with consequent loss to themselves.

Alienation of Timber Prohibited

Towards the end of 1907, the timber-staking business was falling off, and the Government began to realize that, though the system was yielding unprecedented returns to the treasury, the future welfare of the province was being exploited for present gain. On December 27, 1907, all unalienated timber lands were, therefore, withdrawn, by order in council, from all forms of alienation. It soon became evident that, even with a greatly increased annual cut—nearly a billion feet in 1908—the market in sight would not be able to use in 21 years all the timber held under lease and license. There was 619,000 acres under lease, estimated to carry from 10 to 15 billion feet, and 9,000,000 acres under license with over 100 billion feet, in addition to pulp leases and the Crown-granted timber-land, estimated to carry from 20 to 30 billion feet more.

Perpetual Licenses

In 1910, it was decided, therefore, during the next two years, to allow licensees, upon surrendering their 21-year licenses and the payment of a $20 fee, to secure transferable licenses, renewable from year to year, while there remained on the land included in the licenses "merchantable timber in sufficient quantity to make it commercially valuable." The following provision was attached :

"That, whenever the land included within such license shall, after inspection has been made by the Chief Commissioner, be ascertained to be fit for settlement and to be required for that purpose, the Chief Commissioner may require the licensee to carry on and complete the cutting and removal of the

timber thereon within such reasonable time as the Chief Commissioner may fix and prescribe, and, on the expiration of such time or any extension thereof, the license shall be cancelled and the land included therein shall be opened for settlement on such terms and conditions as the Lieutenant Governor may think fit" and it "provided that such renewal shall be subject to such rental or license fee, and such tax or royalty and to such terms and conditions, regulations and restrictions as are fixed or imposed by any statute or order in council in force at the time the renewal is made or at any time thereafter."

Royalties and Rentals

Approximately 12,850 of the licenses were converted into what are called 'perpetual' timber licenses under this regulation. There still remained, however, the uncertainty as to the rental and royalty which might be imposed, and this uncertainty militated strongly against the value of licenses for purposes of financing. In many cases the banks refused to accept these licenses as collateral, since, at any time, the Government could increase the charges to an extent that might seriously reduce prospective profits and, in extreme cases, might amount to confiscation.

The introduction, by the Minister of Lands, during the 1913 session, of a bill to double the royalty charges forthwith justified the attitude taken by the banks, and brought this phase of the system to the attention of the public so forcibly that the impending legislation was withdrawn. Assisted by the co-operation of the lumber and timber interests, the Forest Branch made a careful study of the conditions under which the industry operated, and, as a result, in 1914, a scale of royalties was agreed upon. This scale places the timber licenses on a more secure basis than real property held under Crown grant, so far as governmental charges are concerned.

Royalty on Timber Cut on Crown Lands—Coast—For a period of five years, beginning January 1, 1915, a royalty of 85 cents per M. b.f. upon all timber cut in that portion of the province west of the Cascade range, and suitable for the manufacture of lumber and shingles, and graded under the provisions of the Act as No. 1 or No. 2 Douglas fir, No. 1 or No. 2 spruce, No. 1 or No. 2 cedar, No. 1 or No. 2 pine, or No. 1 or No. 2 cottonwood ; and a royalty of 50 cents per M. b.f. upon all other timber suitable for the manufacture of lumber and shingles.

Southern Interior—During the same period of five years, a royalty of 50 cents per M. b.f., upon all timber suitable for the manufacture of lumber and shingles cut in that portion of the province east of the Cascade range which lies south of the Dominion Railway Belt, or within the watershed of Seymour arm and Adam lake, or within the watershed of the Columbia river, excepting the watershed of the Canoe river.

Northern Interior—During the same period of five years, a royalty of 65 cents per M. b.f. upon all timber suitable for the manufacture of lumber and shingles cut in any portion of the province in respect whereof provision is not otherwise made in this section of the Act.

The grading rules are published in the Royalty Act, 1914, and are fixed until the end of 1924.* The royalty due on spars, piles and poles remains at

*See pp. 167-168, Chap. VIII.

1 cent per four feet of running length ; on railway ties and mining props at 50 cents per M. or per cord, and on shingle bolts at 50 cents per cord (600 b.f.) until the end of 1929.

After 1920, the royalty on timber suitable for the manufacture of lumber and shingles is to be readjusted every five years on the basis of the average wholesale price of lumber, the Government taking a share of the surplus, if any, over $18.00 per M., which is figured as allowing a reasonable profit for the lumberman. The Government share in the increase for the various periods is as follows : 1920-1924, 25 per cent ; 1925-1929, 30 per cent ; 1930-1934, 30 per cent ; 1935-1939, 35 per cent ; 1940-1944, 35 per cent ; 1945-1949, 40 per cent ; 1950-1954, 40 per cent. For each of the foregoing five-year periods the increase in royalty is to be calculated upon the average wholesale selling price of lumber, f.o.b. point of manufacture, for the first four and one-half years of the preceding period.

This schedule of royalties recognizes three important principles ; first, that the public is entitled to a share in the unearned increment due to the increasing timber values ; second, that it is unwise to impose a charge which is liable to force the exploitation of the forest resources beyond the market requirements ; and, third, that security of title is essential in the carrying on of large business enterprises, such as are necessary in the lumber industry of to-day.

Rental on Provincial Timber Licenses—The maximum annual rental that can be collected until the end of 1954 is also fixed at $140 per license of one square mile west of the Cascades, and $100 per license east of the Cascades and including the electoral district of Atlin.

As this scale is printed on every renewal receipt, it is incorporated in the contract and cannot, in future, be changed. The licenses, therefore, are now on a stable basis until the end of 1954.

This arrangement gives the tax-paying public a more than paternal interest in the development and welfare of the lumber industry, for the amount of revenue from this source depends on the prosperity of the industry. The result is that the British Columbia Government is probably doing more in the way of assisting in the developing of the lumber trade than any other forest administration in America.

Forest Protection Fund—In addition to the rental, the licensees are required to contribute annually to the forest protection fund. The levy for this fund at present is 1½ cents per acre.

The outstanding features of these timber licenses in their present form are as follows :

> Though issued annually, they are renewable in perpetuity, providing there is merchantable timber on the ground and the land is not required for settlement.
>
> Settlement is not permitted on land included in timber licenses until examined and found more valuable for agriculture, and sufficient time is allowed for the removal of the merchantable timber.
>
> A maximum rental is fixed until the end of 1954.

The royalty on the timber cut is fixed until the end of 1954, according to a sliding scale, dependent on the value of lumber.

The Government retains right to control the cutting operations.

Together with the owners of other provincial timber, the licensees contribute one-half of the cost of fire protection in the province.

Extent of Alienation under Timber Licenses

On December 1, 1915, there were 13,747 timber licenses in good standing in the province ; 12,581 were renewable in perpetuity if there is merchantable timber on the land, and 1,166 were for a fixed period of 21 years from the date of staking (1907 or earlier).

While the timber leases are nearly all situated on the coast, over one-half of the licenses are east of the Coast mountains. This may be explained by the fact that the lumber industry on the coast was well established before the license system was adopted, and the earlier alienations were necessarily in the form of leases. The development of the industry in connection with provincial lands in the interior has been of a more recent date.

LOCATION OF LICENSES

Forest District	*No. of licenses*
Cranbrook	908
Hazelton	560
Kamloops	1,672
Lillooet	53
Nelson	1,306
Prince Rupert	1,248
Fort George	962
Tête Jaune	1,001
Vernon	328
Vancouver	3,352
Vancouver island	2,357
Total	13,747
East of Cascades	7,046
West of Cascades	6,701

At the close of 1916, the total number of timber licenses in good standing had decreased to 8,129, though 5,828 more were reinstatable and had not been cancelled ; 1,108 had expired before March 31st, 1913, and are not reinstatable. Of those in force, 9,929 had been surveyed, covering 5,776,000 acres. Though 640 acres is allowed for each license, the surveys show an average of only 581 acres per license. The area of the remaining 2,857 unsurveyed licenses cannot exceed 1,828, 490 acres, and, allowing the same average area as for the surveyed licenses, it would total 1,600,000 acres. The total area held under timber license may, therefore, be estimated to be about 7,500,000 acres. A round figure of 1,000,000 acres for timber leases makes a total of approximately 8,500,000 acres held at present under timber licenses and timber leases. This figure may be expected to decrease steadily, as areas are cut over and abandoned. The increasing burden of the carrying charges is already causing the license holders to examine their limits more carefully and to discard the less valuable licenses. The license fees, which, at present, form 57 per cent of the total forest revenue, will naturally continue to decrease from year to year.

Hand-Loggers' Licenses

Hand-loggers' licenses were first provided for in the Land Act, 1888, under the following clauses :

"The Chief Commissioner may, upon the payment of the sum of $10 therefor, grant a general license to any person to cut timber upon Crown lands, not being timber limits, without any reservation as to area ; but such license shall be personal, and shall grant authority to the person named therein to cut timber as a hand-logger, and such license shall be in force for one year from the date thereof, and no longer."

This law imposed no restrictions on the method of logging, and the holders were free to operate on any ungranted timber of the Crown. The same royalty is due for timber cut under hand-loggers' licenses as under special timber licenses. The law remained unchanged until 1906, when the following clause was added : "The holder of a license granted under this section shall not use steam-power or machinery operated by steam-power in carrying on lumber operations under such license."

In 1908, the operations of hand-loggers were restricted to the northern Coast region, and the license fee was increased to $25. This restriction as to the district in which hand-logging could be conducted, was removed the following year, at the request of the labour interests, but the cutting was thereafter limited to certain defined areas, specified in the individual license. The sites for these licenses were to be examined by an officer of the department before the license was issued. The license fee remained at $25, and only those on the list of voters for the Legislature of British Columbia or members of the Indian race were entitled to a hand-logger's license. Timber cut by hand-loggers is subject to the same royalty as that cut on timber licenses.

Wasteful Logging

The indiscriminate cutting of convenient shore timber without any control results in the injury of many good logging sites ; for, as the hand-loggers are not allowed to use steam power, they fail to get to the water a large proportion of the trees they cut down. It is estimated that at least 40 per cent of the trees cut by hand-loggers are wasted in this way. The resulting debris produces a fire menace of the worst kind, since these workings are nearly always situated at the foot of a mountain and at the water's edge, where a destructive fire is most likely to start and gain headway. It is extremely doubtful whether the advantages thus gained in forest utilization, or the furnishing of employment to the nomadic, irresponsible citizens who follow this occupation are commensurate with the resultant damage. The discontinuance of this form of license was recommended by the Forestry Commission in 1910, but such licenses are still issued.

During the last 28 years, hand-loggers have destroyed the timber on over 1,000 miles of shore-line extending back from one to twenty chains, averaging perhaps five chains, and covering an area of 50,000 acres. Though no figures are available as to the amount of timber cut by hand-loggers, it is estimated, from personal observation, that they have marketed perhaps 500 million feet, cut and allowed to go to waste, 300 million, and indirectly caused the destruction of an additional 800 million feet, through fire and windfall resulting from their

operations. About 210 of these licenses have been issued annually during the last few years, the revenue from which amounts to approximately $5,000 annually for license fees, and $19,000 for royalty, on an average cut of 125,000 feet per license.

Hand-logging can undoubtedly be used to advantage in some places where small patches of timber are situated on steep slopes. However, provision is now made for small timber sales which allow the use of steam-power, and, in connection with such operations, cutting regulations and disposal of debris are required. It would appear that the usefulness of the hand-logging system has passed, and that it should be discontinued, as inimical to the object of forest conservation.

Timber Sales

Following the prohibition, in 1907, of the staking of timber licenses, there was no provision in the statutes for the disposal of the timber on Crown lands, until the Forest Act, 1912, authorized the sale, by public competition, of licenses to cut timber under the form of tenure known as 'timber sales.'

The complete withdrawal of Crown timber from sale resulted in the wasting of considerable timber on small areas adjoining alienated lands which were being operated. Very frequently the timber on these lands could be taken out more advantageously, or only, in conjunction with the timber being logged. Usually it could be handled cheaply while the roads and machinery were in operation on adjacent lands, but the cost of exploitation of these small amounts of timber was prohibitive, if worked separately. If left standing after the adjoining timber had been removed, the timber on these areas was exposed to greatly increased fire and wind hazards. The need of clearing the forest from certain lands suitable for agriculture necessitated the disposal of the merchantable timber first. The demand for pulp timber, by new concerns which had not acquired any of the old pulp leases, also made it advisable to allow the sale of at least some classes of Crown timber. Sales of timber chiefly valuable for pulp are made under the form of 'pulp licenses,' which differ somewhat from the ordinary timber sale. It was chiefly with the object of encouraging closer utilization that the 'timber sales' were at first introduced. Finding, however, that the demand for Crown timber on the liberal terms offered by the Government gave promise of considerable revenue, the Forest Branch has encouraged and developed this business, until it forms an important part of the forest administration.

Method of Conducting Sale

The legislation governing these timber sales has been revised nearly every year to facilitate the disposal of timber in this way. Its chief features, as applied in 1918, are as follows: The timber is first selected, cruised and surveyed by the Forest Branch, and full information as to the kinds and quantity of timber is supplied to prospective purchasers. The Forest Branch fixes an upset stumpage price which must be offered over and above the royalty. The sale is then advertised in the *British Columbia Gazette* and local newspapers for two months if the amount of timber is over 1,000,000 b.f., or for one month, if between 500,000 and 1,000,000 b.f. When the stumpage value is less than $100, advertisement

is not necessary. Sealed tenders are accepted up to a certain date, then the tenders are opened and the license awarded to the highest bidder. Small sales are handled directly by the local officers of the Forest Branch in the district where the timber is situated.

Payment on Timber Sales

A deposit, covering the cost of cruising, surveying and advertising, and 10 per cent of the estimated total stumpage value, must accompany each tender. The time allowed for cutting in ordinary timber sales is definitely fixed at the time of sale, usually one or two years, and seldom over five years, based on the understanding that the tract will be operated immediately. Rentals and royalties are due on the same scale on these timber sales as on special licenses. The stumpage and royalty are collected as the timber is cut and scaled by the Government scalers, so that the purchaser pays only for the merchantable timber which he actually secures.

Inspection of Operations

The operations are inspected frequently, and, before the contract between the Government and the purchaser is concluded, the tract must be completely logged to the satisfaction of the Forest Branch. Failure to complete the exploitation of the timber sale to the satisfaction of the Forest Branch within the contract time results in the loss by the purchaser of his deposit of 10 per cent made at the time of tendering. The only means of securing an extension of the time is to have the uncut area put up for sale again and to buy it in at the price then prevailing.

From the standpoint of conservation, it is undesirable that further alienation of timber on a large scale should be encouraged, except where its exploitation permits of the utilization of material which would otherwise be wasted, or where the removal of the timber would facilitate settlement or is required for local development. As a general principle, the opening up of new territory, even though accessible, should be discouraged, since the value of the stumpage will naturally enhance in the future, and since the legitimate demands of the market for all except possibly local uses are more than amply provided for by timber already alienated.

Pulp Licenses

Owing to the large investment necessary for the manufacture of pulp and paper, and to the necessity of such industries having an assured supply of raw material for a considerable period in advance, it was found necessary to extend the time of cutting and also to sell larger areas of timber for pulp purposes than for ordinary timber sales. Precautions are taken, however, to see that these licenses are granted only to concerns which are prepared to operate the tracts within a reasonable time. The sale of pulp licenses is, therefore, limited to purchasers who have either already expended at least $350,000 in the erection of a mill for the manufacture of wood pulp or paper, which is not appurtenant to any existing pulp lease, or who are prepared to execute a guarantee bond of at least $50,000 that such a mill will be built within three years, not less than $100,000 being spent during each of the first two years for that purpose. The licenses issued must be appurtenant to the pulp- or paper-mill, and the amount of timber

to be taken up is determined by the capacity of the mill, not more than 30 years' supply being allowed at any one time.

The rental payable by lessees operating a pulp-mill is one-half that on special licenses, namely, $70 per square mile on the coast and $50 in the interior. The royalty on pulpwood cut from these pulp licenses is 25 cents per cord of 700 b.f. When saw timber is cut from pulp licenses, the lessee pays, in addition to the ordinary royalty on saw material, the difference in rental. Using 15,000 b.f. as the equivalent of one acre, this would be approximately 1½ cents per M. b.f. This arrangement enables the lessee to use the timber for the most suitable purpose, and, at the same time, does not give the pulp licensee any advantage over the timber licensee.

In 1914, ten sales of pulp timber, comprising 20,425 acres and estimated to carry 221,845,663 b.f., were awarded. The revenue anticipated from these sales is $267,613.32, which amounts to $1.20 per M.

The extent of the timber-sale business is shown by the following table :*

EXTENT OF TIMBER SALES

	1913	1914	1915	1916
Sales awarded—				
Number	...	71	98	133
Total area	...	28,132	12,990	23,318
Estimated quantity of timber sold—				
Saw timber (M. b.f.)	...	278,078	94,550	136,354
Piles and poles (lineal feet)	...	12,910	12,174	435,810
Cordwood shingle bolts (cords)	...	7,615	12,373	26,667
Ties (pieces)	...	18,520	.....	92,000
Posts	...	25,000*	.....	100†
Estimated revenue from sales	$238,476.00	$349,958.69	$152,589.97	$259,765.15
Timber cut on timber sales—				
M. b.f.	...	36,660	70,983	63,055
Lineal feet	...	.....	115,389	225,799
Cords	...	.....	12,454	8,426
Revenue received in addition to royalty—				
Stumpage	$18,719.92	$36,545.33	$67,250.42	$68,779.87
Rentals	2,597.95	3,477.87	3,830.89	5,235.35

*Pieces. †Cords.

Provincial Forest Reserves

The Forest Act, Sec. 12, provides that the Lieutenant-Governor in council may, by proclamation, set aside definite areas as permanent forest reserves, to be withdrawn from sale, settlement or occupancy and devoted to the perpetual growing of timber. Provision is made for the acquisition, by exchange or purchase, of any vested rights within the forest reserves which may have been created, and for the control and management of such reserves "for the maintenance of the timber growing, or which may hereafter grow, thereon, for the protection of the water supply, and for the prevention of trespass thereon."

*A copy of a timber sale contract, as filled out for a pulp license, appears as Appendix No. 1.

Elk River Forest Reserve

The only reserve as yet established under this Act is one of about 57,600 acres in the Elk River valley, notice of which appeared in the *British Columbia Gazette* for December 31st, 1914. None of the land is suitable for agriculture.

In addition to reserves which may be specially created by proclamation of the Lieutenant-Governor in Council, a blanket reservation of all statutory timber-land from sale or settlement has existed since 1884. Until the Forest Branch undertook the inspection of the land before the grants were issued, this reservation was of comparatively little effect. Upon the expiry of the lease or license all lands which have been thus held are placed under reserve until examined and released by the department. All other lands which, upon examination, are found to be more valuable for forest purposes than for agriculture, though they may not carry sufficient timber to classify them as statutory timber-land,* may be specifically withdrawn from disposal. Under this latter head, burned-over lands, lands carrying young forests, or lands which adjoin valuable timber which would be menaced by the clearing of such lands, may be withdrawn from sale or pre-emption.

Land Classification

It is the policy of the Lands Department to have all lands examined by the Forest Branch and classified in regard to the forest conditions before applications for purchase or pre-emptions are dealt with. As far as possible, this is being accomplished, and the Forest Branch has examined in advance large areas of Crown land which it was thought might be applied for. As a result of these examinations, during 1914 and 1915, a total of 1,628,541 acres was placed under reserve, as follows :

PROVINCIAL FOREST LAND RESERVED

Forest district	1914	1915	Total
	Acres	Acres	Acres
Cranbrook	2,097	101,823	103,920
Fort George	41,250	26,880	68,130
Hazelton	251,888	8,180	260,068
Island	100	4,509	4,609
Kamloops	162,464	472,878	635,342
Lillooet	126,290	764	127,054
Nelson	22,664	.....	22,664
Prince Rupert	21,500	.....	21,500
Tête Jaune	141,190	6,200	147,390
Vancouver	131,560	14,801	146,361
Vernon	53,955	37,548	91,503
Totals	954,958	673,583	1,628,541

To insure permanency, which is essential in forest management, authority to create or cancel forest reserves is usually vested in Parliament or the Legislature. In British Columbia, however, reservations on provincial lands may be cancelled wholly or in part, at any time by order in council.

*Lands carrying 8,000 b.f. per acre when situated west of the Coast mountains, and 5,000 b.f. per acre when east of the Coast mountains or in the electoral district of Atlin.

In proclaiming reserves on forest lands it is not the intention to withdraw any of the natural resources from legitimate use. The timber can be disposed of by timber sales, and, after it is removed, the land may be opened for settlement if found suitable for agriculture, and if this course is considered to be in the public interest. Mining, fishing, hunting or similar uses of the land are not interfered with by the reserve.

As land classification proceeds, the area of reserved lands will undoubtedly be greatly increased. The advantage of placing large contiguous areas under more intensive forest management than is possible with the reserve scattered in small parcels all over the province should be recognized. Important watersheds, where the maintenance of a forest cover is necessary for sanitary reasons, or for the control of stream flow, should be placed under reserve, and, if necessary, the power conferred by the Forest Act should be taken advantage of to acquire the private rights in the area. It is of vital importance that the water supply of cities, such as Victoria and Vancouver, should receive every protection that can be afforded, and the easiest and most effective means to accomplish this is to maintain the forest cover on the watersheds.

Provincial Parks and Game Reserves

Two parks, Strathcona park and Mount Robson park, have been created by acts of the Legislature for the purpose of providing permanent "pleasure grounds for the benefit, advantage and enjoyment of the people of British Columbia."

Strathcona park, set aside in 1911, is situated at the headwaters of Campbell river, near the centre of Vancouver island. Including additions which have been made since 1911, the park covers approximately 530,566 acres, and includes some of the finest mountain and forest scenery on the Pacific coast. Roads and trails are being constructed to make it accessible to the public.

Mount Robson park, created in 1913, includes approximately 409,600 acres of the western slope of the Rocky mountains in the vicinity of Yellowhead pass. Within its boundaries are many of the most prominent peaks of the system. Mount Robson, the namesake of the park, is the highest mountain peak in the Canadian Rockies, 13,068 feet, and a large number of others, including mounts Resplendent, The Helmet, Lynx, Whitehorn, etc., exceed 10,000 feet. The source of the Fraser river is in this mountainous region. The park is traversed by the Grand Trunk Pacific and the Canadian Northern railways.

Forest protection of the provincial parks is being provided by the Forest Branch, and improvements, such as roads and trails, by the Public Works Dept. Timber licenses and other vested rights, existing prior to the establishment of the parks, are not prejudiced thereby, though provision is made for the acquisition of all such rights.

Proposed Park near Vancouver

A request is being made by the British Columbia Mountaineering Club to have another park established, to include the rugged mountainous region to the north of Vancouver. Within 40 miles of Vancouver, and a few hours' walk from the Pacific Great Eastern

railway, is an area estimated to be 250 square miles in extent, a large proportion of which is covered by perpetual snow and ice. A number of the finest peaks in the Coast mountains are within the proposed park, including mount Garibaldi, 8,700 feet; mount Mamquam, 8,400 feet; Castle Towers, 8,000 feet; Black Tusk, 7,350 feet; Red mountain, the Sphinx, Table mountain, Columnar mountain and many others. Several lakes and the headwaters of such important rivers as the Mamquam, Pitt, Stave, Glacier, etc., are situated in this region.

Game Reserves

In addition to the parks, three game reserves, with an aggregate area of approximately 895,120 acres, have been created. Land in these reserves is temporarily withdrawn from sale, preemption or lease. The object of the reserves is to provide havens for game and hunting therein is prohibited.

Yalakom game reserve includes about 170,000 acres in the watershed of Yalakom river, Lillooet district, a region famous for big-horn sheep. Smoky River reserve, approximately 566,160 acres, covers the watersheds of Clearwater and Little Smoky rivers, on the north side of the upper Fraser river. Elk River game reserve, about 149,760 acres, includes a mountainous district lying to the west of Elk river, Kootenay district, and extends to the headwaters of Bull and White rivers, tributaries of Kootenay river.

Unalienated Provincial Lands

Of the Provincial Crown lands available for disposal, the following areas have been applied for and are in process of being permanently alienated.*

Applications to purchase	511,932	acres
Pre-emptions	992,001	"
Surveyed mineral claims†	409,066	"
	1,912,999	"

As a result of the passing of the Soldiers' Homestead Act, 1916, requiring the completion of the payments on application to purchase, over 2,229,000 acres has reverted to the province and is available for settlement. Of this, 1,887,000 acres had been surveyed by the applicants.

As an endowment to the Provincial University, 771,401 acres of timberland has been set aside. These lands are to be sold when conditions are favourable and the proceeds are to be devoted to the support of the University. An additional 189,000 acres has been reserved for sale by auction.

The unsurveyed and unencumbered Crown lands are subject, in many instances, to temporary reserves, established at various times for various purposes.

Land Open for Pre-emption

Only Crown lands which do not carry merchantable timber are open for settlement. An additional safeguard to the forests is afforded by section 12 of the Land Act, which provides that

*Statement supplied by Forest Branch for March 31st, 1917.
†Recorded mineral claims which are not surveyed are not included.

NATURAL REPRODUCTION OF DOUGLAS FIR AFTER LOGGING AND SLASH BURNING, 20 YEARS OLD.
NEAR GRIEF POINT, MALASPINA STRAIT

DOUGLAS FIR REPRODUCTION, AFTER FOREST FIRE, 17 YEARS OLD. POWELL LAKE

"the Minister may refuse to grant pre-emption records on any area of land, not exceeding 640 acres, bounded on two or more sides by timber lands." Advantage has been taken of this provision to prevent the establishment of small clearings within forested areas, where the fire hazard created by such settlements is out of proportion to the value of the land for agricultural purposes.

Though settlement is not confined to surveyed lands, the Dept. of Lands has endeavoured to anticipate the demand for pre-emptions by surveying large areas where settlement is likely to take place and which are not distant from railway communication. The greater portion of these lands is situated in the northern interior, and is tributary to the Grand Trunk Pacific Ry. The amount of surveyed land open for pre-emption in the various land districts is as follows :*

District	*Area available, acres*
Cassiar	147,518
Cariboo	766,318
Coast Range 5	238,004
Coast Range 4	205,785
Lillooet	519,319
Kamloops	69,686
Queen Charlotte Islands	213,477
Peace River	126,886
Rupert	26,443
Nootka	2,909
Similkameen	22,005
Kootenay	25,553
Sayward and New Westminster	16,430
Osoyoos	9,180
Texada	1,096
Yale	3,865
Clayoquot	1,506
Total	2,395,980

Land Classification Required

No systematic classification for agricultural purposes was conducted while this land was being surveyed. The classification attempted was left to surveyors, few of whom were qualified, and, as this survey work was paid for on an acreage basis, it was not conducive to careful elimination of non-agricultural lands. In British Columbia, where soil conditions are so variable, much more detailed examination of the land is required than in more level regions. The result of this lack of knowledge of the soil has been that, in many instances, settlers have taken up lands totally unsuitable for agriculture, and much of the land now offered for pre-emption is also of this class.

In many instances, settlers have been allowed to locate where the agricultural land was not sufficient to support even a small community, and such settlers are doomed to be shut off from markets and from even the most primitive social advantages. The pre-emptor is usually a man of small financial means and very frequently of limited experience in the selection of lands. It should, therefore, be the duty of the Government to safeguard him from

Report of the Surveyor General, 1915.

wasting his time, money and energy on land which is not suitable for agriculture, or in localities which are impossible of community development.

Dominion Lands in British Columbia

The Federal Government owns three separate tracts in British Columbia, known as the Railway Belt, the Peace River Block, and the Crowsnest Pass Coal Lands Reserve.

The Railway Belt

The Railway Belt was granted to the Dominion by the Province to aid the building of the Canadian Pacific railway through British Columbia. In consideration of the land to be so conveyed, the Dominion Government agreed to pay to the province, from the date of union, the sum of $100,000 per annum. The Railway Belt was conveyed to the Dominion in 1883. It includes the land within twenty miles on each side of the Canadian Pacific Ry. from the Alberta boundary to a westerly limit, bounded by the Meslilloet river, the North Arm of Burrard inlet and the western boundaries of townships 39, 38, 2 and 1, west of the Coast meridian.

Peace River Block

To compensate for the land within the Railway Belt which the province had disposed of prior to the transfer, the Dominion was given the right to select an additional 3,500,000 acres of provincial public lands. The selection was not made, however, until 1907, when a block approximately 73·6 miles square was selected in the Peace River district adjoining the Alberta boundary.

Within these two areas the Federal Government administers all the unalienated lands in respect to settlement, timber, grazing, stone, gypsum, marl, coal, petroleum and natural gas, and, in the Peace River Block, administers all minerals, except gold and silver. The Province administers the waters and minerals excepted from Federal control as stated above ; it also controls taxation of private lands and the administration of justice.

Crowsnest Pass Coal Lands Reserve

The Crowsnest Pass Coal Lands reserve consists of two blocks of 5,000 and 45,000 acres, respectively, in the Kootenay district, to the east of Fernie. This land was acquired by the Federal Government from the Crowsnest Pass Coal Company in return for certain concessions granted to the company. None of this land has, as yet, been alienated, though both blocks are fairly well timbered, chiefly with Engelmann spruce and lodgepole pine, with a scattering of balsam and fir. As the name implies, the principal value of the reserve is the coal deposits.

Disposition of Land in the Railway Belt

Situated as it is along the main line of the Canadian Pacific Ry., which, until recently, was the only railway traversing the province, the Railway Belt is an important part of British Columbia. The total area of the Belt is estimated at 10,976,000 acres, of which 287,900 acres is covered by water. For administrative purposes the forests are divided into two regions, defined as east and west of Yale, respectively, Yale being taken as the summit of the Coast mountains and the dividing point between the coast and the interior conditions. The following table shows the disposition which has been made of the lands in the Railway Belt :

LAND SITUATION IN THE RAILWAY BELT

	West of Yale	East of Yale	Total
Permanently alienated :	Acres	Acres	Acres
Lands disposed of by Provincial Government prior to Dominion control	183,000	112,000	295,000
Lands sold by Dominion	55,000	60,000	115,000
Lands homesteaded (patented and unpatented)	313,000	671,000	984,000
Total	551,000	843,000	1,394,000
Temporarily alienated:			
Timber berths—			
in forest reserves	....	81,920	81,920
in Dominion parks	....	30,560	30,560
outside reserves and parks	301,210	711,630	1,012,840
Total	301,210	824,110	1,125,320
Grazing leases—			
in forest reserves	....	49,120	49,120
in Dominion parks	....	....	....
outside reserves and parks	....	317,325	317,325
Total	....	366,445	366,445
Reserved :			
Forest reserves	....	1,759,700	1,759,700
Parks	....	718,700	718,700
Coquitlam reserve	55,700	....	55,700
Indian reserves	39,000	133,700	172,700
Total	94,700	2,612,100	2,706,800
Unalienated and unreserved :			
Water area	....	....	287,900
Land area	....	....	5,574,460
Total	....	....	5,862,360
Total area			10,976,000

Quarrying and mining leases may be granted in respect to either permanent or temporarily alienated lands, and cannot, therefore, be classified, but in the whole Railway Belt include only 81,994 acres.

The control of lands for settlement is under the British Columbia Lands Branch of the Dept. of Interior. Dominion lands are now reserved exclusively for free homesteads and no pre-emptions are granted within the Railway Belt. The size of the homesteads varies with the nature of the land. In the coast region of the Fraser valley, and in the more fertile valleys in the interior which are adapted for fruit growing, the maximum size is 40 acres. In the Kamloops district, where general farming and stock raising are conducted, it is 160 acres. Before the patents or Crown grants are issued, personal residence on the land being homesteaded is required for six months per year for three consecutive years. The clearing and cultivation of from 4 to 50 acres, depending on local conditions, is also required.

Lands that carry more than 2,000 b.f. per acre of merchantable timber are classified as timber-lands, and may be reserved from settlement upon the recommendation of the timber inspector. If homestead entries are granted on

lands carrying in excess of 2,000 b.f. per acre, permits to cut the timber are required. These are granted free for clearing purposes, but, if the timber is sold, a royalty or stumpage charge of $1.50 per M. b.f. is collected. All amounts so paid by the settler are refunded when he completes his homestead duties and secures his patent, as the provision is made chiefly to discourage fraudulent entry.

Squatting on timbered lands, or land in a timber berth, whether timbered or not, gives the settler no right to either the land or the timber, and results in ejectment proceedings and the loss of any improvements he may have made on the land. Provision is made, however, for the opening up of logged-over portions of timber berths, when such is advisable, that legitimate settlement may be provided for. The Dominion Government imposes no taxes on the land, but, as soon as the patents are issued, the Provincial Government may tax the land and improvements as real and personal property.

Patented Lands

Though the general policy has been to reserve all the agricultural land for homesteaders, some 115,000 acres have been sold, chiefly under special conditions requiring reclamation by dyking or irrigation.

No royalty is reserved on the timber cut from these patented lands, and the logs are exportable without charge. In the earlier grants no reservation was made of the timber, with the result that, in the lower Fraser valley, the land, even if heavily timbered, is practically all in private hands. This timber is, at present, supplying over 40 saw- and shingle-mills, nearly all of which are of small or medium size. This supply of timber is, however, rapidly being exhausted. Nearly all the land in the lower Fraser valley is valuable for agricultural purposes, especially for fruit, vegetables and dairying, and greater efforts should be made to have it cleared and put under cultivation as soon as possible after logging.

Dominion Timber Licenses

The Federal Government has always followed the leasing, or licensing, system of timber disposal, retaining the ownership of the land and an equity in the timber in the form of a royalty. The tracts held under these cutting licenses are known variously as Dominion 'timber berths,' 'leases' or 'limits.' The Dominion licenses are sold by public competition for a cash bonus, payable at the time of sale. Though the licenses are issued for one year only, they are renewable from year to year as long as there is merchantable timber on the ground and the land is not required for settlement. The berths may be of any shape or of any size up to 25 square miles.

Ground Rent and Royalty

The difference between the Coast and Interior types of forest is recognized in the annual rental charge, which, on the Coast, is 5 cents per acre, or $32 per square mile, and in the Interior, $5 per square mile, as compared with $140 and $100 per square mile, respectively, for provincial licenses. The royalty on the timber cut is the same

throughout all Dominion lands, viz.: Sawn timber, 50 cents per M. feet, board measure; railway ties, 8 feet long, 1½ cents each; railway ties, 9 feet long, 1¾ cents each; shingle bolts, 25 cents per cord; all other products, 5 per cent on the sale price.

In addition to the rental, the licensee contributes a portion of the cost of fire protection service, the license holders' share being worked out on the basis of one-half the acreage cost of the service in the district, averaging about one cent per acre per annum.

In Manitoba, timber licenses were granted as early as 1879, for an annual rental of $2 per square mile and a royalty of 5 per cent of the sale value of the cut, in addition to the bonus paid at the time of sale. The first definite regulations were framed in 1883. They restricted the area to 50 square miles, and limited the tenure to one year, with provision for renewal, if the land was not required for settlement. The rental was then fixed at $5 per square mile and the royalty at 5 per cent of the sale value of all the products. The operation of a mill with a 10,000 b.f. daily capacity for six months each year was obligatory. Provision was made for the submission of tenders requiring payment in the form of a cash bonus, if competition for the timber developed. In 1885, public competition was definitely required.

These regulations applied to Manitoba, the Northwest Territories (which included the present provinces of Alberta and Saskatchewan) and the Railway Belt in British Columbia as far west as the 120th meridian (about 25 miles east of Kamloops). Between the 120th meridian and Yale there were no restrictions as to area or time limit; the rental was $50 per license and the royalty was 30 cents per tree felled and 75 cents per M. b.f. of timber cut. Between Yale and the Pacific, the area per license was limited to 1,000 acres, unless the capacity of the mill appurtenant was over 25,000 b.f. per day, when 2,000 acres was allowed for each 25,000 b.f. of capacity. The term of the license was limited to four years. The rental in this district was $10 per license and the royalty 15 cents per tree and 20 cents per M. b.f.

In 1887, the central district was extended eastward to Eagle pass, just west of Revelstoke, and, in 1889, another change was made, abolishing the central district and applying the Coast rate of rental, $32 per square mile, to all lands west of Eagle pass. To encourage the export trade in lumber products, the Dominion Government, in 1889, adopted the same policy as the province in granting a rebate of one-half the royalty for all the cut exported. This, however, was discontinued in 1901.

In 1900, the dividing line between the Coast and Interior was moved to Yale, a point on the Fraser river which traverses the Coast mountains, or 'Cascade mountains,' as they were formerly known. Since that time, there has been little or no change in the regulations, except that, in 1901, the exportation of logs cut from Dominion lands was prohibited, and an assessment for fire protection was made.

Sale by Public Auction

Prior to 1908, timber licenses were disposed of by means of sealed tenders, sent to the Dept. of the Interior, Ottawa, but, since that time, the sales have been by public auction in the

various districts in which the berths are situated. Before the sale, the Government has the berths surveyed and the timber cruised, and an upset price is fixed for the license as a whole.

The sealed tender system was not advantageous to either the Government or the purchasers. The open bidding has resulted in very much higher bonuses being paid, and purchasers who can use the timber to the best advantage are given every opportunity to secure it. In one case, a berth was sold by sealed tender for $5,000, and the purchaser was next day offered $40,000 for it by a competitive bidder. In many similar instances, under the old system, the Government lost a large share of the stumpage value.

Terms of Payment

The bonuses offered are not paid on a stumpage basis, as in the case of provincial timber sales, but the following terms are allowed for payment: Amounts of $1,000 and under are payable in cash at time of sale; from $1,000 to $5,000, one-half cash and a note for three months for the balance; $5,000 to $10,000, one-third cash and notes for three and six months, respectively, for the remaining two-thirds; over $10,000, one-quarter cash and notes for three, six and nine months, respectively, for the three quarters. These notes must bear interest at the rate of five per cent per annum.

Estimate of Stand Not Supplied

Under its timber sales policy, the Provincial Government informs the prospective purchasers as to the quantity of timber shown by the cruise, while the Dominion Government does not. In the opinion of many this is a mistake on the part of the latter, as it restricts the bidding to those who are able to thoroughly inspect the tract before the sale. Though it is impossible for the Government to guarantee that its estimate will be borne out by the cutting, the publication of the cruise gives the bidders confidence and provides a definite basis upon which to estimate. Private sales could not be conducted successfully without furnishing such essential information as to the amount and kinds of timber involved, and there seems to be no good reason for the Dominion not doing so. Undoubtedly much more interest would be taken in the sales of Dominion timber licenses if this information were supplied.

Terms Subject to Change

The Government reserves the right to change any of the regulations covering these licenses, including the rental or royalty, at the expiration of any annual renewal.

Dominion licenses contain a number of conditions, failure to fulfil any of which renders the license liable to confiscation, or to the imposition of penalties, such as increase of rental or dues. Chief among these is the 'operation clause,' which provides that:

"The licensee shall have in operation, within one year from date when he is notified by the proper officer of the Dept. of Interior that the Minister of the Interior regards such a step as necessary or expedient in the public interest, and keep in operation for at least six months of each year of his holding, a saw-mill in connection with his berth, capable of cutting, in twenty-four hours, 1,000 feet board measure for every two-and-a-half square miles of the area licensed, or shall establish such other manufactory of wood goods as the Minister of the Interior accepts as equivalent thereto.

"Provided, however, that, notwithstanding anything in these regulations, a licensee may, in lieu of erecting a mill, be permitted to have the timber cut from the berth or berths held by him manufactured at a mill which is not his own property, provided that he cuts from the said berth or berths at the rate of 100,000 feet annually for each square mile held by him under the license."

As no operator can conduct little camps on each of his berths every year, the enforcement of this clause is not economically possible; nor is it advisable to force cutting when he cannot obtain a reasonable price for his lumber. It often occurs that the saw-mill operator can secure his supply of logs more advantageously from settlers who wish to clear their land than from his own berths, and, if required to cut his licensed timber, he could not offer a market for the settlers' timber. For a few years, an attempt was made to enforce this clause by increasing the rentals, but it was found to be contrary to the principles of conservation and was abandoned. The principle of requiring the operation of such claims is sound, provided care is taken that timber is not alienated except when and where a market exists for the product. Practically all the merchantable timber is now in private hands, and much of it is quite inaccessible at the present price of lumber; consequently, the enforcement of this clause would necessitate wasteful exploitation and an ultimate loss, not only of direct revenue, but of productive profits to the country.

Silvicultural Regulations

Another regulation limits the minimum diameter of trees which may be cut to 10 inches on the stump, except for purposes of road-building or other necessary construction. Seed trees must be left 'as directed,' and all merchantable material must be used from the trees cut, and tops, branches and other debris must be disposed of in accordance with the directions of the officers of the department in such a way as to prevent, as far as possible, the danger of fire. In addition the licensee is required to prevent all unnecessary destruction of young growth.

Regulations not Enforced

These regulations are not enforced, however, as the timber berths are administered by the Timber and Grazing Lands Branch of the Dept. of the Interior, which is not supplied with a technical staff of the training and judgment necessary to efficiently direct such operations.

Effect of Cutting to Diameter Limit

The application of a general diameter limit to *all* species and to *all* forest types is of doubtful value, from either a business or silvicultural viewpoint. The object of leaving the small trees is presumably to encourage reproduction, but, in the forests of British Columbia, the most obvious result of cutting to a diameter limit of 10 inches would be to encourage the reproduction of such inferior species as lodgepole pine, hemlock and aspen, at the expense of the more valuable Douglas fir, red cedar, white pine, yellow pine and spruce. The regulations provide, however, for the leaving of such seed trees as may be designated ; they thus offer an opportunity for a large measure of control over the reproduction. The regulation regarding the disposal of the logging debris is important, both from a fire-protection standpoint, and as a means of securing desirable reproduction. It has been found that, for the Coast region, at least, slash burning is almost

necessary for a successful reproduction of Douglas fir. The elimination of waste in logging is also a most desirable object.

In view of the importance of maintaining the productiveness of the forests, and of the fact that the licenses have been granted with these regulations attached, it is to be regretted that steps have not been taken to apply silvicultural methods of cutting, as far as they are practicable under the existing conditions. Representations have frequently been made to the Dominion Government by the Commission of Conservation and the Canadian Forestry Association, calling attention to the urgent need for such a change in organization as would result in the adequate enforcement of cutting regulations on licensed timber berths, with a view to securing better forest reproduction and a greater reduction of the fire hazard.

Scaling of Timber Cut

The licensee is required to furnish each year to the Dominion Timber Agent having jurisdiction, sworn returns showing the quantities manufactured, sold or disposed of, of all sawn lumber, timber, or any other product of timber from the berth, with the exception of slabs for fuel purposes or sawdust, and the price or value thereof. A bush count is also required to be kept of all saw logs and other timber cut upon a berth, as well as the number of pieces hauled therefrom, and the books containing these records must be duly sworn to and returned to the Dominion Timber Agent. Timber cut on Railway Belt lands north and east of Yale may be scaled only by persons authorized in writing by the Minister or his appointed agent. Timber cut on Dominion lands south and west of Yale is to be scaled by a Dominion Timber Scaler holding a scaler's license from the British Columbia Government, and in accordance with standard methods.* The payment of fees is based upon the log scale, for which the British Columbia rule is in effect. Situated close to the railway, and generally easy of access, most of the merchantable timber in the Railway Belt has been alienated in timber licenses during the last 30 years, and, though large amounts of timber have been cut from the berths, these lands still remain an important forest asset. The low rental and the lower royalty, together with the sense of security in Dominion timber licenses as compared with the original form of provincial licenses, has given the former a preference from the investor's point of view.

Timber Permits

In the Railway Belt

Permits may be granted, without competition, to settlers and others to cut up to 100 cords of shingle bolts for sale, upon payment in advance of dues at the rate of 50 cents per cord. Permits may also be secured to cut fire-killed timber for the manufacture of lumber, cordwood, poles, ties, etc., upon payment of dues.

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*See 1917 Dominion Timber Regulations, Nos. 26 and 27. It is now proposed to make a further change by providing that the scaling south and west of Yale shall be done by a scaler holding a British Columbia scaler's license, but employed by the Department of the Interior, instead of by such men in the employ of the licensees.

HEMLOCK REPRODUCTION, UNDER MATURE DOUGLAS FIR AND HEMLOCK STAND

LOGGING DEBRIS. THIS CONSTITUTES A DANGEROUS FIRE HAZARD AND RENDERS REPRODUCTION DIFFICULT

Forest Reserves

Throughout the Railway Belt, as on other Federal lands, the Dominion has set aside large areas of non-agricultural lands "for the maintenance, protection and reproduction of the timber growing, or which may hereafter grow, thereon, for the conservation of the minerals and the protection of the animals, birds and fish therein, and for the maintenance of conditions favourable to a continuous water supply."

Administered by Forest Branch

These reserves are under the control of the Director of Forestry, who, as head of the Forestry Branch, has the assistance of a staff of technically-trained foresters to administer the forests. The areas to be reserved are first withdrawn from settlement by the Minister of the Interior, and then permanently set aside by Act of Parliament, and no portion can subsequently be withdrawn from the reserves without the consent of Parliament. No lands included within forest reserves may be sold, leased or otherwise disposed of, or be located or settled upon, and no person may use or occupy any part of such lands, except as authorized by the Dominion Forest Reserves and Parks Act or regulations made thereunder.

Licenses in Forest Reserves

Until the first Forest Reserves Act was passed in 1906, no considerable areas had been set aside for forest purposes in British Columbia, though Glacier park was established in 1888, Yoho park in 1902, and Long Lake Forest reserve in 1902. Before the reserves were created, practically all of the accessible stands of merchantable timber had been disposed of under timber license, and, though these berths might be included within forest reserves, any right or interest conveyed by the license is not prejudiced thereby. Section 58 of the Dominion Lands Act provides, however, that such licenses shall be subject to any provisions contained in the Forest Reserves Act or in regulations made thereunder, providing for the protection of game, the prevention of fires and the preservation and reproduction of timber.*

Though this section of the Lands Act seems clearly to place the operations of the timber berths in the forest reserves under the control of the Forestry Branch, there appears to be some doubt as to the authority of the Forestry Branch in regard to these berths, and, except for forest protection, the forestry administration has been confined to the unlicensed lands. In this connection, Sir Clifford Sifton, in his annual address in 1915, as Chairman of the Commission of Conservation, made the following comment :

"We are still faced with the anomalous situation of a practically complete divorce between the theory and practice of forestry on Dominion Lands held

*Sec. 58, Dominion Lands Act : "Licenses issued under the authority of this Act, for timber berths which are located within the boundaries of any reserve established by the Dominion Forest Reserves Act, chapter 56 of the Revised Statutes, 1906, or by any Act subsequent thereto which sets apart forest reserves, shall be subject to any provisions contained in that Act, or in regulations made thereunder, providing for the protection of game, the prevention of fires, and the preservation and reproduction of timber : Provided that, when any portion of such a timber berth has not upon it timber in merchantable quantity of the kind and dimension described in the license, the Minister may withdraw that portion from the license, notwithstanding anything in this Act or any other Act or in any regulation made thereunder ; and upon such withdrawal, the ground rent shall be reduced in proportion to the area withdrawn."

under license to cut timber. This matter was discussed last year, on the basis of a report made for the Commission by J. H. White, of the Faculty of Forestry at Toronto. It was then shown that, while the Forestry Branch is well equipped with men technically trained in forestry, and in administering the forest reserves, as well as affording fire-protection both within and outside these reserves, it has absolutely no connection, at the present time, with the administering of cutting regulations on the licensed timber berths, although many of these timber berths are included within the boundaries of the reserves. This is because the timber berths are not legally a portion of the forest reserves. At the same time, the Timber and Grazing Branch, which is charged with the administration of the timber berths, has not, as far as known, even one man in its employ who has had any training in forestry.

"As stated last year, the principal practical features of present-day forestry are : Such control of the methods of cutting as shall ensure the perpetuation of the forest, and such measures of brush disposal, as a fire-preventive measure, as may be found practicable and desirable under the conditions of each individual case. The licensed timber berths naturally include the bulk of accessible merchantable timber on Crown lands, and it is obviously illogical and thoroughly undesirable in every way to permit the cutting of this timber without the most careful and intelligent enforcement of the existing regulations, which have for their object the perpetuation of the forest. Such enforcement is, however, not now provided, and is impossible under existing conditions or organization."

Regulations on Reserves

The regulations governing the forest reserves are designed to permit of the fullest use of the natural resources compatible with the maintenance of a permanent sustained production. Leases of surface rights are permitted for mining claims, churches, schools, club-houses, sanatoria, and cemeteries and summer resort lots. The grazing of stock is permitted in forest reserves under regulations which enable the maximum use of the pasturage without danger of deterioration, and permits to cut hay are issued where advisable. The timber is disposed of under a system of permits or timber sales which are issued for a stated amount of timber to be cut in a limited time.

Settlers' Permits

Settlers are allowed up to 25 cords of dry wood free each year, for their own use as fuel, and any occupant of a homestead who has no timber suitable for building, fencing or fuel on his land may secure a free permit to cut up to the following maximum amounts :

(*a*) 3,000 lineal feet of building timber, no log to be over 12 inches at the butt end, unless the timber is cut from dry trees, in which case timber of any diameter may be taken.

Should the building timber be sawn at a mill, the permittee will be entitled to receive, free of dues, 9,250 b.f. of lumber therefrom, and no more.

(*b*) 400 roof-poles to be used for such purpose.

(*c*) 500 fence-posts, 7 feet long, and not to exceed 5 inches at the small end.

(*d*) 2,000 fence-rails.

Should the house timber be sawn at a mill, payments for sawing must not be made by way of toll, as the full quantity of lumber cut from the logs must be used on the permit-holder's homestead.

Permits to cut timber up to the following maximum amounts are granted without competition for purposes and at prices as follows :

(*a*) To actual settlers (sub-section 'a,' section 16), 10,000 b.f. of saw-logs, 500 fence-posts, 500 fence-rails not over six inches in diameter at the butt, 1,000 lineal feet of round building timber, 25 cords of wood for fuel.

(*b*) To miners and prospectors (sub-section 'b,' section 16), 50,000 b.f. of timber, or its equivalent.

(*c*) For municipal and public works (sub-section 'c,' section 16), whatever timber is required, and for churches and schools in rural districts 20,000 b.f. or its equivalent.

(*d*) To occupants, permittees or lessees (sub-section 'd,' section 16), 3,000 lineal feet of building logs, 500 roof-poles not over six inches in diameter at the butt.

(*e*) For irrigation purposes (sub-section 'e,' section 16), 50,000 b.f., or its equivalent.

(*f*) To residents of towns and villages, for the erection of buildings for their own use, in quantities not to exceed 3,000 lineal feet of round timber and 500 roof-poles, not to exceed 6 inches in diameter at the butt in any one year, at an upset price not less than that fixed by these regulations for permits.

(*g*) To any applicant, for his own use or for sale or barter, green or dry cordwood at not less than 25 cents per cord, and in amounts not to exceed 400 cords on any one permit.

The schedule of fees to be charged for timber under these permits is as follows :

(*a*) Cordwood (for fuel only), 25 cents per cord.

(*b*) Mining props and poles, other than telegraph and telephone poles, nine inches or more in diameter at butt, one-half cent per lineal foot ; under 9 inches in diameter at butt, one-quarter cent per lineal foot.

(*c*) Fence posts, one cent each for 7 foot posts ; one-half cent for each additional foot (not to exceed 5 inches in diameter at top).

(*d*) Poles or rails, two cents each (not to exceed 6 inches at butt).

(*e*) Telephone and telegraph poles, one-half cent per lineal foot for poles 25 feet and under ; one cent per lineal foot for poles over 25 feet.

(*f*) Shingle bolts, 50 cents per cord.

(*g*) Railway ties, eight feet long, 3 cents each ; each additional foot 1 cent.

(*h*) Sawlogs, $1.50 per M b.f.

(*i*) Round building timber, one-half cent per lineal foot.

Timber Sales

Tenders may be called for larger amounts of timber, up to 5,000,000 b.f., to be removed within five years. The amount to be sold and the upset price is fixed by the Director of Forestry, and the sale advertised for 30 days in a newspaper circulating in the district in which the timber is situated. Applicants for such sales must deposit $50, which is forfeited in case the timber is not sold at the upset price fixed. Tenders

must be accompanied by a deposit of not less than one-fifth of the total dues, if they do not exceed $5,000, or one-tenth, if they do exceed that amount, and this deposit is retained, to be applied on the two last quarterly payments.

No person to whom a sale of timber has been made is eligible to tender on another sale, until either the conditions of the first contract have been fulfilled, or the time allowed is due to expire within the next six months.

Cutting regulations, designed to meet the local silvicultural conditions, are inserted in the contract for each sale, so that the purchaser knows what will be required of him, and is prepared to carry out the instructions of the officers in charge. The elimination of waste, disposal of brush and provision for reproduction of the desired species are secured in this manner.

The following are the Dominion forest reserves in British Columbia, the total area of each, and the area temporarily alienated, under timber licenses and grazing leases :

Reserve	Area	Timber berths included	Grazing leases included
	Acres	Acres	Acres
Yoho	104,640	....	....
Glacier	67,840	....	....
Larch Hills	14,880	....	....
Mount Ida	28,960	7,680	....
Fly Hills	143,200	5,120	480
Martin Mt	21,760	....	800
Niskonlith	202,720	40,000	6,560
Monte Hills	116,960	....	800
Tranquille	185,984	2,560	....
Long Lake	168,134	24,000	11,680
Nicola	323,680	2,560	6,160
Arrowstone	163,200	....	....
Hat Creek	217,760	....	12,640
	1,759,718	81,920	39,120

Agricultural Land in Forest Reserves

The forest reserves in the Railway Belt do not carry a great deal of merchantable timber, aside from that included in timber berths. The land in these reserves is better adapted to forest production than to any other purpose, care having been taken to exclude all large bodies of agricultural land. Such small areas of the latter as were unavoidably included when the reserves were established, are now being opened for settlement under special arrangements, and provision for the utilization and improvement of meadow lands have been made, though these are of value only for hay production.

Over a very large proportion of the area there are to be found excellent stands of young forest growth, which it is the duty of the Government to protect until it reaches maturity. Situated as these reserves are, chiefly in the drier districts of the province and covering the headwaters of the streams which supply the agricultural valley with water for irrigation, the maintenance of a permanent forest cover within their boundaries is most important.

Dominion Parks

The Federal Government has permanently set aside, by Act of Parliament, several large areas of Dominion lands in the Railway Belt as national parks. These areas, in addition to being forest reserves, provide pleasure grounds for the benefit and enjoyment of the people of Canada and of visitors who may care to use them. They are administered by the Parks Branch of the Dept. of the Interior, under the Commissioner of Dominion Parks.

There are three of these parks in the Railway Belt, the Yoho, covering 560 square miles ; the Glacier, 468 square miles, and the Revelstoke, 95 square miles. They include some of the most magnificent scenery to be found in the whole Rocky Mountain system, and the object of their administration is, therefore, primarily to preserve and make accessible the wonderful scenic attractions of the parks.

Before the establishment of the parks, over 30,000 acres had been licensed as timber berths, over which the parks administration has no control, except in matters of fire protection. Dominion licensed timber lands are administered by the Timber and Grazing Lands Branch of the Dept. of the Interior. There is considerable timber not included in timber berths, but the cutting of this timber is permitted only for improvement purposes, such as the removal of dead timber or for thinning stands that are too dense.

The Forest Reserves and Parks Act authorizes the Governor in Council to make regulations :

(*a*) For the protection, care, management, control, maintenance and improvement of Dominion parks, and their use and enjoyment as public parks and pleasure grounds ;

(*b*) For the conduct of persons residing in, or making use of, any park ;

(*c*) For the lease for any terms of years of such parcels of land in the parks as he deems advisable in the public interests, for public purposes, for the construction of buildings for ordinary habitation, for purposes of trade and industry, for the accommodation of persons resorting to the parks ;

(*d*) For the maintenance and improvement of properties in the parks that have been sold or leased ;

(*e*) Prescribing the class and style of buildings and other structures to be erected in the parks and the material of which they must be built, and for classifying building and fire areas ;

(*f*) For the control and licensing of business, trades and traffic of every description within the parks, and the levying of license fees ;

(*g*) For the construction, operation and maintenance of roads, side-walks, street lighting, water-works, sewage, fire protection and sanitation systems, and other public utilities within the parks, and for levying contributions upon the properties benefited thereby and the persons interested in such properties, and for the sale or forfeiture of the interests of such persons in such properties when such contributions are not paid ;

(*h*) For the preservation of public health and the prevention of the spread of disease.

Indian Reserves

Scattered throughout the province are over one thousand tracts of land which have been set aside for the sole and permanent use of the Indians. As a protection against sale by the Indians, these lands are held in trust for them by the Dominion Government, the administration being under the Department of Indian Affairs. British Columbia claims reversionary rights, whereby, in the event of any of these lands being sold or withdrawn from the reserves, the complete title is vested in the province.

Land, timber or other rights on these reserves can be secured only from the Dominion Government, upon the consent of all those Indians in the tribe to whom the particular reserve was assigned, and, in order to make the title to any such rights unassailable, it is necessary, in addition, to secure from the Provincial Government the assignment of its reversionary rights. The difficulty of acquiring all these assignments of rights has, fortunately for the Indians, almost completely prevented the exploitation of the natural resources, except by the Indians themselves.

The following table shows the numbers and areas of the Indian reserves in the various districts in British Columbia, as they stood in 1917:

Agency	Number of Indians	Number of reserves	Total area, acres
Stikine	675	2	415
Nass	1,840	63	62,854·91
Queen Charlotte	600	25	3,484·50
Bellakula	1,529	65	22,667·93
Kwawkewlth	1,134	91	16,607·49
West Coast	1,773	149	12,357·10
Cowichan	1,713	72	19,879·59
New Westminster	2,422	149	39,975·42
Lytton	2,238	160	54,480·61
Williams Lake	1,229	64	62,430·77
Babine and Upper Skeena	1,926	45	30,073·80
Stuart Lake	1,421	42	22,047·94
Kamloops	2,296	104	173,226·66
Okanagan	872	43	145,928·21
Kootenay	576	11	46,141·38
Nomadic Indians (estimated)	2,500	..	....
Totals	24,744	1,085	712,571·31

The reserves are estimated to carry a total of about 2,500,000 M. feet, many of them being well timbered. Realizing that this timber should be used, the department has adopted a permit system of timber disposal, following closely that in force by the Dominion Forestry Branch on the forest reserves. Wherever possible, the Indians are encouraged to do the logging and sawing themselves.

Plate XV

DOMINION FORESTRY BRANCH LOOKOUT CABIN, ON GREEN MOUNTAIN,
LONG LAKE FOREST RESERVE, KAMLOOPS DISTRICT

Photo. by C. J. Haddon

PACKING WIRE FOR FIRE PATROL TELEPHONE LINE, COLUMBIA VALLEY

CHAPTER V

Forest Administration on Provincial Lands*

THE forests of British Columbia are administered by the Forest Branch of the Department of Lands, and all matters pertaining thereto are under the control of a staff of technically-trained foresters. Few government forestry staffs on this continent have such complete control over the forests and forest lands as has the Forest Branch in British Columbia. It has charge of the protection of the forests, of their alienation and exploitation, and of the collection of the revenues derived therefrom. During the last few years, the development of markets for lumber has become an important feature in its work.

Development of Administration

In the early stages, forest matters were dealt with by the officials of the Department of Lands. The work centred chiefly in Vancouver, at the office of the timber inspector. A forest ranger with a launch patrolled the 700 miles of coast-line between Vancouver and Prince Rupert. The forests of the interior country were administered by collectors, who paid occasional visits in quest of royalty due from operators who had cut Crown timber. In those days, even though logging operations were conducted on a small scale, this slender staff was unable to cope with the situation effectively. Later, the long-standing conflict between the coast logger, as the vendor of the timber, and the mill-man, as the purchaser, compelled the Government to act as arbitrator. An official scale, known as the 'British Columbia' log rule, was adopted, and was made the compulsory basis for all dealings in timber west of the Cascades.† To put this scale into effective operation, the Government appointed official salaried scalers, acting under a supervisor connected with the timber inspector's office at Vancouver. The cost of the work was defrayed by levying a charge of five cents per 1,000 board feet on all timber measured. In 1906, prohibition of the export of unmanufactured logs increased the duties of the timber inspector's office and necessitated a launch patrol of the boundary.

Forest Protection Undertaken

With the growth of population, public sentiment in favour of forest protection developed, and the Government undertook the protection of forests from fire. At centres such as Vancouver and Revelstoke, fire wardens were appointed, and the number of these gradually increased, until, in 1909, 37 wardens were patrolling the forests. Thus, forest protection gradually developed, until it constituted a separate branch of departmental work.

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*The authors are indebted to the courtesy of Mr. M. A. Grainger, Chief Forester of British Columbia, for a large part of this discussion, and much of the text is a direct quotation from a memorandum prepared by him.

†Includes the Coast mountains, properly so called, and the Cascade mountains.

Forest Commission of Enquiry

In 1909, a Royal Commission of Inquiry on Timber and Forestry was appointed to conduct an inquiry "into and concerning the timber resources of the province, the preservation of the forests, the prevention of forest fires, the utilization of timber areas, afforestation, and the diversification of tree growing, and generally, all matters connected with the timber resources of the province". This commission consisted of Hon. Fred. J. Fulton, K.C., as chairman, and A. S. Goodeve and A. C. Flumerfelt. Mr. M. A. Grainger, now Chief Forester, acted as secretary of the commission. After extensive investigations, covering not only the local situation, but also the methods in use in other places, the commission reported that large appropriations must be made for forest protection, and a well-equipped, well-manned, specialized forest service brought into being. The establishment of the Forest Branch was the result. The report of this commission, published in 1910, contained a wealth of information in regard to the status of the forest lands in British Columbia, and the revenues derived therefrom. Previous to this, very little was known concerning the disposition that had been made of the public forests or of their importance to the welfare of the province. The recommendations* made by this commission show that the situation was carefully studied, and the findings were, to a large extent, followed in the framing of the Forest Act of 1912.

The Forest Act, 1912

With the passage of the Forest Act in 1912, it became possible to create an extensive force to carry out the comprehensive scheme of forest administration that had been recommended. Hon. W. R. Ross, Minister of Lands, secured the assistance, as consulting forester, of Mr. Overton W. Price, to whom the organization of the U. S. Forest Service is so largely due. A technical staff was rapidly recruited, and a definite scheme of forest administration put into practical effect before the close of the year.

Organization by Forest Board

Under the new Forest Board, the province was divided into 11 forest districts, with headquarters at Cranbrook, Hazelton, Kamloops, Lillooet, Nelson, Prince Rupert, South Fort George, Tête Jaune, Vancouver, Vernon and Victoria. A district forester was appointed to take charge of each of these divisions and, under him, a technical assistant, whose duties consisted chiefly of cruising, reconnaissance, and silvicultural matters; also rangers, each in charge of the supervision of the forest districts; scalers and check scalers—the latter in those districts in which the mills do their own scaling; forest guards, who are temporary employees concerned only with forest protection, patrol, improvements or fire fighting; and others necessary for the varying classes of work in the different districts.

In charge of this district organization was a headquarters office, under a chief forester, and four assistant foresters, each concerned with a separate branch of the general work.

The Timber Management office deals with the forest atlas, land classification, products, scaling, seizure, silviculture, timber sales, timber marking,

**Final Report of the Royal Commission of Inquiry on Timber and Forestry, 1909-1910*, p. D43.

timber inspection, and trespass; also all work connected with the utilization of lumber products, a matter which, in recent years, has developed into considerable importance.

The Operation office undertook all organization and personnel matters and also control of forest protection work. Later, the investigation of grazing on vacant lands, lumbering and publicity were added, and the duties of this office now comprise organization, fire protection, education and publicity, improvements, reconnaissance, grazing, and library.

The Records office deals with appointments, revenue and supervision of expenditure, the status of land, sale and royalty, drafting of legislation, and the general collection of statistical data.

Under the Timber Surveys office, considerable work was done until the outbreak of war, with the object of obtaining a general knowledge of the timber resources of the province; but, when war broke out, most of this work was abandoned, and the duties of the office were taken over by the other offices.

In the first two or three years of the existence of the Forest Branch a large amount of cruising and land examination work was carried on under the direct supervision of the Victoria office. As the district offices developed, however, this work was gradually transferred to them.

The crisis created by the depression in the lumber industry, which was so severely felt in the three years beginning with 1913, was met by an energetic campaign to develop the market for British Columbia forest products.

Market Extension

An investigation into the reasons for the lack of progress in British Columbia's export lumber trade for the past fifteen years had been initiated during 1915. Early in 1916, the need of extending this investigation to the overseas markets was brought to the attention of the Dominion Department of Trade and Commerce; and, in March, H. R. MacMillan, Chief Forester of the province, was appointed by Sir George Foster to visit these markets as Special Trade Commissioner.

In the United Kingdom, with the assistance of Sir Richard McBride, Agent General for British Columbia, he drew the attention of the Imperial authorities to the fact that lumber purchases even for the War Office were being made from American firms, to the detriment of the British Columbia industry. As a result, orders amounting to over $200,000 were placed in British Columbia, and the Forest Branch attended to the filling of the orders and the shipping of the lumber. Valuable information in regard to the market for lumber in various forms was also secured and given to the public through the *Weekly Bulletin* of the Department of Trade and Commerce. Mr. MacMillan, later, visited Holland, South Africa, Australia, New Zealand and India.

Forest Revenue

The forest revenue of British Columbia came into prominence as a consequence of the numerous stakings of timber licenses in 1906, 1907 and 1908. In 1900 the forest revenue was $142,300; in 1909 it had risen to nearly $2,500,000. By calendar years the revenue has been as follows :

FOREST REVENUE BY FISCAL YEARS, 1900-1910

Year	Licenses	Leases	Crown-grant taxation	Royalty	Cordwood	Scaling fees	Transfers	Hand-loggers	Total
1900	$ 7,150	$37,231	......	$ 89,362	$ 7,117	......	......	$1,530 (approx.)	$ 142,390
1901	12,708	45,608	......	81,047	14,342	......	......	1,630 "	155,335
1902	57,918	39,213	......	91,648	7,986	......	......	1,900 "	198,666
1903	135,552	124,635	......	137,702	5,347	......	......	2,590 "	405,826
1904	177,984	92,761	......	178,730	4,061	......	......	1,830 "	455,366
1905	271,935	100,007	......	196,187	2,138	......	......	4,200 "	574,467
1906	513,497	87,954	$34,355	213,860	2,205	$4,018	$ 778	3,230	859,877
1907	1,339,351	77,661	41,693	206,751	1,717	18,729	4,848	5,730	1,696,480
1908	2,290,473 (*a*)	88,869	72,740	304,235	1,041	17,553	10,211	658	2,785,807
1909	1,983,015	77,473	95,712	264,544	494	19,115	7,982	1,625	2,449,960
1910 (*b*)	1,605,713 (*c*)	10,659	(*d*)	293,206	392	24,902	9,147	3,625	1,947,644

(*a*) Two payments on one license occurring to some extent within the 365 days of this year.
(*b*) From timber inspector's report.
(*c*) Includes $15,800 for penalties for deferred payment of license fees.
(*d*) Preceding figures for fiscal year.

NOTE.—This table, except for the 1910 figures, was taken from the *Report of the Royal Commission of Inquiry on Timber and Forestry, 1909-10*, which made the following comment in this connection :

"As the sums derived from the taxation of Crown-granted timber are included—in the public accounts—in the general item for 'Wild, Coal and Timber Lands,' we have no means of ascertaining the actual amount received in each year from this source. From the tax rolls, however, we know the total sums that should, in theory, have been paid upon Crown-granted timber. The actual payments are doubtless somewhat less than these amounts, on account of unpaid arrears ; and, moreover, upon prompt payment a discount of 10 per cent is allowed. If we deduct 10 per cent from the whole sum due for each year we probably arrive at a close approximation to the true receipts."

STATEMENT OF FOREST REVENUE, 1911-1916
(CALENDAR YEARS)

	1911	1912	1913	1914	1915	1916	Total (6 years)
Timber-license rentals	$1,931,375 (*a*)	$1,937,194 (*a*)	$2,112,876.18	$1,555,980.28	$1,140,656.53	$1,138,879.22	$ 9,816,961.21
Royalty and tax	425,571	489,377	482,707.05	391,118.36	351,310.13	456,863.29	2,596,946.83
Trespass penalties	18,625	25,651	9,016.95	7,170.95	3,520.54	893.39	64,877.83
Lease rentals	75,700	79,262	119,291.44	88,792.08	120,132.35	77,040.59	560,218.46
Scaling fees	28,590	36,833	23,978.99	30,472.32	27,893.16	32,590.20	180,357.67
Scaling expenses	......	......	1,759.41	1,805.82	2,564.71	3,158.71	9,288.65
Seizure expenses	......	......	......	270.90	85.71	1,364.84	1,721.45
License penalties	......	......	24,291.00	25,335.00	16,692.69	28,524.00	94,842.69
Timber stumpage	......	......	18,719.92	36,545.33	67,250.42	68,779.87	191,295.54
Transfer fees	12,864	11,440	10,385.00	7,085.00	4,400.00	3,670.00	49,844.00
Hand-loggers' license fees	3,575	4,125	5,025.00	5,200.00	5,550.00	7,100.00	30,575.00
Interest	14,644	19,237	17,208.84	115.13	1,117.81	100.09	52,422.87
Timber-mark fees	......	......	924.50	508.50	137.00	......	1,570.00
Timber-sales rentals	......	......	2,597.95	3,477.87	3,830.89	5,235.35	15,142.06
" cruising	......	......	1,140.40	1,550.83	2,183.42	1,148.74	6,023.39
" advertising	......	......	691.40	534.05	532.71	391.89	2,150.05
Scalers' examination fees	......	......	585.00	425.00	60.00	225.00	1,295.00
Copies of documents	......	......	......	569.57	128.00	401.80	1,099.37
Exchange	......	......	119.95	61.96	17.33	45.22	244.46
Miscellaneous	......	......	1,469.73	......	......	......	1,469.73
	$2,510,944	$2,603,119	$2,832,788.71	$2,157,018.95	$1,748,063.40	$1,826,412.20	$13,678,346.26
Taxes from Crown-granted timber lands	$ 143,880	$ 150,460	$ 166,540.00	$ 185,661.00	$ 174,495.00	$ 179,528.56	$ 1,000,564.56
Total revenue from forest sources	$2,654,824	$2,753,579	$2,999,328.71	$2,342,679.95	$1,922,558.40	$2,005,940.76	$14,678,910.82

(*a*) Includes perpetuity fee.

PROPORTION OF THE TOTAL PROVINCIAL REVENUE DERIVED FROM THE FORESTS, BY FISCAL YEARS

Year	Forest revenue	Total Provincial revenue	Percentage from forest resources
1901	$ 115,594	$ 1,605,920	7·2
1902	161,071	1,807,925	8·9
1903	298,217	2,044,630	14·6
1904	405,748	2,638,260	15·4
1905	486,516	2,920,461	16·7
1906	643,827	3,044,442	21·1
1907	1,305,327	4,444,593	29·4
1908	2,424,668	5,979,054	40·6
1909 (9 mos.)	1,920,349	4,664,500	41·2
1909-1910	2,448,150	8,874,742	27·6
1910-1911	2,654,824	10,492,892	25·3
1911-1912	2,753,579	10,745,709	25·6
1912-1913	2,999,329	12,510,215	24·0
1913-1914	2,342,680	10,479,259	22·4
1914-1915	1,922,558	7,974,496	24·1
1915-1916	2,005,941	6,291,694	31·9
1916-1917	2,338,333	6,906,784	33·9

The phenomenal increase in the total annual revenue from 1910 to 1914 was due chiefly to increased sales of public lands. When the payments are completed on the land purchases, as required by the Soldier's Homestead Act, 1916, the revenue from this source will be small, as, with the exception of some townsite property and a relatively small acreage reserved for auction, the Crown lands are now withdrawn from sale. The relative importance of the forest as a source of revenue is, therefore, practically certain to increase rather than decrease in the future.

The large forest revenue during 1907-1913 was derived mainly from timber-license fees. When these licenses were staked, no survey of the land was required; and, as they were mostly speculative, little care was taken in locating the claims. The trading in these licenses and the increased burden of the annual license fees, however, have resulted in the surveying and the more careful cruising of the timber on a considerable proportion of the licensed lands. As a consequence, upwards of 1,500 licenses have been discontinued, representing a decrease of nearly $200,000 in the annual revenue. As more of the licenses are surveyed and cruised, and as logging proceeds, the revenue from this source will continue to decrease. The lowering of the license fees in the interior from $115 to $100 also meant a direct decrease of over $100,000; but it probably obviated a much greater falling off, which would otherwise have resulted through the abandonment of the claims by the licensees.

Since the outbreak of the war, the Forest Relief Act has given protection to the holders of timber licenses who have been unable to maintain their annual payments of rental, and the revenue from this source has shown, in consequence, a considerable temporary decrease. As the arrears are subject to heavy interest charges, ranging up to 25 per cent per annum, and, as considerable investments have already been made in most of the licenses now in arrears, it is apparent that, as soon as normal conditions have been restored, a considerable amount of arrears of revenue will be forthcoming. The normal forest revenue at the present time may be estimated at from $2,500,000 to $3,000,000.

Revenue from Logging Operations

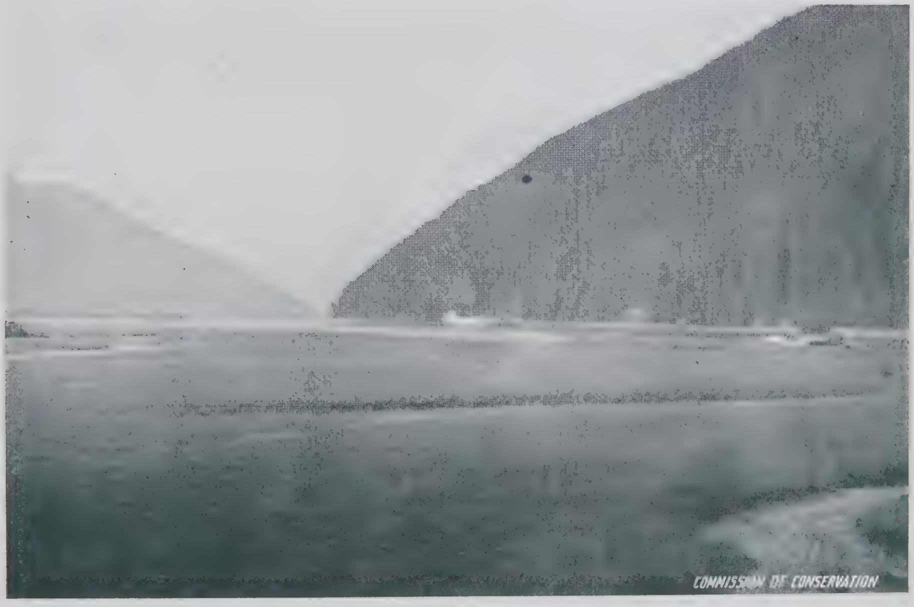
Revenue from the exploitation of the timber is becoming a more important factor and, as the revenue from rentals decreases, royalty and stumpage must be more largely depended upon to furnish the forest revenue. The amounts due upon the operations conducted in the various forest districts during the year 1916 are shown in the table on page 122. Royalty and the manufacture tax yield five-sixths of the revenue from operations. The former is collected on all timber cut from Crown lands and from the more recently granted freehold lands. The manufacture tax is levied on timber cut from lands in respect to which no royalty is payable, and includes also the tax on logs exported. Stumpage derived from timber sales, in addition to the royalty, has yielded from $60,000 to $80,000 per annum during the last three years. Scaling fees and expenses represent little, if any, net revenue to the Government.

Over 70 per cent of the revenue from logging operations is collected in the Vancouver district. Next in importance is the Cranbrook district. The increased lumber production in 1916 resulted in nearly $100,000 more being collected for royalty and manufacture tax than in 1915, while for 1917, there was a still further increase of $105,195.

REVENUE FROM LOGGING OPERATIONS, 1916

Forest district	Amount charged						
	Royalty and tax	Scaling fees	Trespass penalties	Seizure expenses	Scaling expenses	Stumpage	Totals
Nelson	$ 25,323.90	......	$ 451.79	$ 7.60	......	$ 923.51	$ 26,706.80
Vernon	14,268.46	......	205.50	24.75	......	210.17	14,708.88
Kamloops	558.71	$ 81.85	151.88	......	......	......	792.44
Prince Rupert	17,686.01	......	210.97	5.00	......	2,550.53	20,452.51
Hazelton	954.19	......	......	......	......	......	954.19
Fort George	3,003.68	.90	177.62	34.06	......	791.58	4,007.84
Lillooet	287.33	......	142.80	14.25	$ 7.50	301.30	753.18
Cranbrook	71,778.16	48.83	31.00	133.00	......	2,484.61	74,475.60
Vancouver	341,898.23	31,828.99	342.29	748.20	2,965.37	55,724.86	433,507.94
Island	24,816.09	4,379.99	......	......	449.37	44.00	29,689.45
Totals	$500,574.76	$36,340.56	$ 1,713.85	$ 966.86	$3,422.24	$63,030.56	$606,048.83
Totals—1915 operations	$401,383.84	$30,836.03	$2,313.15	$1,796.23	$3,210.62	$80,042.30	$519,582.17
" 1914 operations	427,601.00	30,067.00	12,891.00	865.00	2,272.00	60,055.00	533,751.00

BLOW-DOWN IN HEMLOCK-BALSAM STAND, QUATSINO SOUND, VANCOUVER ISLAND



LOOKING DOWN PORTLAND CANAL, FROM STEWART

Crown-granted Timber-lands

The Forest Branch has no control over the taxation of Crown-granted lands, nor is it credited with the revenue derived therefrom.* The Forest Branch does, however, collect royalty for the timber cut from certain Crown-granted lands and a manufacture tax on the timber cut from other lands.† The tax on the timber land should, nevertheless, be considered a direct forest revenue. The tax on this land is based on a rate of two per cent of the assessed valuation, which is determined by local assessors. No system or organization is provided for cruising or properly classifying the land, and there is reason to believe that a considerable area of timber-land is not properly classified. A better knowledge of the timber on these lands would, in many instances, result in higher valuations being placed on the properties. Crown-granted timber is the highest priced timber on the coast; as most of it was alienated in the early days, it is, as a rule, of choice quality and favourably situated; and also, on a considerable proportion of the Crown-granted lands, no royalty is payable on the timber when cut. For these reasons, Crown-granted stumpage sells for at least $1.00 per thousand more than similarly situated licensed timber. The assessed valuations given in the following tables would seem to be much too low, especially for the Coast districts, designated as Victoria, Cowichan, Alberni, Nanaimo, Comox and Vancouver.

CROWN-GRANTED TIMBER-LANDS

	Area of private timber-lands, acres	Average assessed value, per acre
1911	824,814	$8.72
1912	874,715	8.60
1913	922,948	9.02
1914	960,464	9.66
1915	913,245	9.55
1916	922,206	9.73

AREA AND ASSESSMENT VALUE OF TIMBER-LAND BY ASSESSMENT DISTRICTS

Forest district	Acreage, 1916	Increase or decrease in acreage over 1915	Average assessed value per acre	Change in value per acre since 1915
Victoria	16,942	− 592	$13.30	−0.10
Cowichan	87,077	− 496	14.88	+0.14
Alberni	44,368	− 350	18.31	−0.08
Nanaimo	78,244	+ 160	12.83	+2.64
Comox	217,625	+ 286	13.99	+0.10
Rossland	24,478	+ 40	4.03	No change
Kettle River	5,094	− 765	3.00	No change
Slocan	44,423	−2,879	5.29	+0.01
Vancouver	7,428	− 58	15.73	+0.13
Nelson	177,096	+7,075	3.85	−0.02
Vernon	6,422	No change	4.99	No change
Golden	77,910	No change	3.87	−0.04
Revelstoke	48,439	No change	11.55	−0.02
Steele	86,660	+6,540	6.51	−0.10
Totals	922,206	+8,961	$ 9.73	+0.18

*See page 85 for taxation of Crown-granted timber-lands.
†See page 85 for royalty in respect to Crown-granted timber-lands.

It is evident, from a study of the conditions, that the revenue from the forests must be maintained by production rather than by speculative alienation. Increase in royalty charges has, to some extent, augmented the revenue, but the most effective means to this end is to stimulate production by increasing the market for forest products. British Columbia can increase her cut five fold without endangering her forest capital. From a cut of a little over 1,000 million feet in 1915, a revenue of $351,310 was secured from the royalty and the manufacture tax. Since the royalties increase with the price of lumber (over a minimum price of $18 per M.), the Government is financially interested not only in the volume of production, but in the prosperity of the lumber industry. Timber sales have provided a new source of revenue which may be developed within certain limits. In 1915, $71,080 was received from stumpage and rentals from the timber sales.

Forest Protection Tax

The forest protection tax, levied on all timber-land* in the province, can not properly be considered as revenue, since the funds thus collected from the timber owners are reserved exclusively for forest protection. The forest protection fund is discussed more fully at page 125 *et seq.*

Forest Expenditure

Out of an average annual revenue from its forests of over $2,000,000, British Columbia spends approximately $400,000 in their protection and administration. Since the cost of protection is borne jointly by the Government and the timber-owners, the expenditures for this purpose must be kept separate from administrative expenses, which are paid entirely from the provincial treasury.

FOREST EXPENDITURE IN BRITISH COLUMBIA, 1910-1916

Fiscal year	Administration	Protection	Total
1910-11	$ 65,822 (*a*)	$219,493 (*b*)	$285,315
1911-12	60,071 (*c*)	144,590	204,661
1912-13	162,904 (*d*)	115,743	278,647
1913-14	231,374	166,133	397,507
1914-15	275,302	166,000 (*e*)	441,302
1915-16	241,591	166,000	407,591

(*a*) Ending March 31.
(*b*) Including expenses of this period paid subsequently.
(*c*) Including travelling expenses of officers.
(*d*) Including $15,000 for construction of launches.
(*e*) Heavy expenses incurred in fire fighting made it necessary to cover a deficit of $21,000 by an advance to the Forest Protection Fund in addition to this grant.

Administration expenses include salaries of head-office staff, of district foresters and their clerical assistants, expenses of cruising and land examination, cost of scaling, collection of revenue and publicity work carried on in connection

*Timber-land is defined on page 98.

with the extension of markets' propaganda. The salaries of rangers and patrolmen, the cost of fighting fires, and of such facilities as telephones, launches, etc., which are necessary to protect the forests from fire, are paid out of the forest protection fund. The launches are charged to the forest protection fund only when actually engaged in patrol work; when used in land examination, inspection of logging or collection of revenue, their cost and maintenance are charged to administration.

During the last four years, the expenditure for purposes other than protection may be classified as follows:

	Administrative salaries	Miscellaneous	Lumber markets	Total
1913-14	$155,712	$75,622	....	$231,337
1914-15	190,390	73,234	$11,678	275,302
1915-16	171,035	40,476	30,080	241,591
1916-17 (9 mos.)	87,852	42,847	80,000	130,695

GENERAL ADMINISTRATIVE EXPENDITURE FOR FISCAL YEAR 1916-1917

	Salaries	Miscellaneous	Total
Headquarters	$ 55,289.11	$ 9,149.30	$ 64,438.41
Cranbrook	5,721.28	3,255.32	8,976.60
Fort George	4,290.21	3,987.12	8,277.33
Hazelton	2,577.41	1,239.45	3,816.86
Island	3,501.32	4,390.69	7,892.01
Kamloops	4,957.61	2,184.66	7,142.27
Lillooet	2,938.30	900.69	3,838.99
Nelson	4,777.54	1,352.25	6,129.79
Prince Rupert	4,038.97	7,488.85	11,527.82
Vancouver	33,653.51	27,143.79	60,797.30
Vernon	3,376.27	2,225.47	5,601.74
Totals	$125,121.53	$63,317.59	$188,439.12

Forest Protection

Protection of the forests from fire is the first and most important duty of a forest administration. Since its organization, in 1912, the Forest Branch has devoted the major portion of its efforts towards establishing an efficient system of fire prevention and control. It is doubtful if any forest service was ever confronted with a more difficult problem than that presented by conditions in British Columbia. The forests are scattered over an immense area of land (226,186,240 acres), which is, for the most part, rough and mountainous. Throughout the greater portion of this territory there are practically no means of communication or transportation and no resident population from which help could be obtained to control the fires. The salt-water shore-line, due to the numerous fiords and islands, is estimated at over 7,000 miles, almost every mile of which presents a fire hazard. To protect the heavy stands of timber on the coast it was necessary to provide numerous launches. Trails, telephone lines, observation posts and numerous other improvements were also necessary.

Educative Campaign

In addition to the natural difficulties, the indifference of the public to the destruction of the forest by fire necessitated an energetic educative campaign to obtain the co-operation necessary for results. A Bush Fire law was passed in 1884, providing for the imposition of penalties for setting fire; but, lacking an adequate organization for enforcement, it was of little benefit. The prevailing attitude of the public, and particularly of the lumbermen, prospectors and settlers, whose lives were spent in the forests, was that fires were inevitable and frequently more beneficial than otherwise. The popular belief that the supply of timber was inexhaustible was expressed in the cheapness of stumpage. Unless his equipment was destroyed, the lumberman considered the damage occasioned by forest fires as negligible. The prospector welcomed fire, since it laid bare the rocks in which he sought his fortune. To the settler, the forest only encumbered the land, and was an impediment to the tillage.

Each summer, it was not unusual for from two to four months, to have the smoke from forest fires hanging over the coast like a fog—frequently presenting a menace to navigation. Still, no concern was felt in regard to the millions of feet of timber which were annually being destroyed.

Fire Wardens

For a number of years, during the danger months, a few rangers were employed, but their duties consisted chiefly in fighting fires after they had become dangerous. The force was too limited for an effective patrol to prevent the starting of fires. The inspection and supervision of these temporary and inexperienced rangers, scattered throughout the province, was left to one permanent fire warden. The natural result was that the service was ineffective and subject to more or less ridicule. By degrees, the number of rangers was increased until, in 1911, the force consisted of 110 district wardens who, in turn, were under the direction of two supervisors of wardens. The Forest Branch was created in February, 1912; the service was reorganized to some extent and the rangers were given closer supervision. The following year the service was increased and much more efficiently organized.

The protective service entailed not only an increased personnel, but necessitated the provision of means of transportation, communication and other equipment.

The immense area which each ranger has to protect, even with the increased staff, is shown in the following table :

AREA OF ADMINISTRATIVE AND PROTECTIVE UNITS, 1916

Forest district	Total land area, acres	No. of ranger districts	Average area, ranger districts, acres	No. of regular guard districts	Average area guard districts, acres	Maximum No. guards and patrolmen during season	Average minimum area guard and patrol districts, acres
Cranbrook	7,560,000	3	2,520,000	15	504,000	20	378,000
Fort George	39,375,000	4	9,843,750	28	1,406,325	31	1,270,000
Hazelton	23,100,000	3	7,700,000	14	1,650,000	14	1,650,000
Island	6,390,000	2	3,195,000	16	399,375	18	355,000
Kamloops	9,470,000	2	4,735,000	14	676,428	15	631,000
Lillooet	12,670,000	2	6,335,000	8	1,583,750	8	1,583,750
Nelson	7,950,000	4	1,987,500	22	361,364	23	345,650
Prince Rupert	21,880,000	3	7,293,000	8	2,735,000	8	2,735,000
Vancouver	15,770,000	6	2,628,000	27	584,074	37	426,210
Vernon	5,835,000	2	2,917,500	11	530,500	12	486,500
Totals, 1916	150,000,000	31	4,838,700	166	920,245	186	806,450
" 1915	150,000,000	36	4,166,600	177	847,450	202	742,550
" 1914	150,000,000	35	4,285,714	191	789,473	302	499,000

Forest Protection Fund

It was felt that, since the timber-owners and the Government were jointly interested in the protection of the forests, each should contribute toward the expense, and the 'forest protection fund', maintained equally by the timber-owners and the Government, was established. The first year, an assessment of one cent per acre was levied on all timber licenses, leases and Crown-granted timber-land.* This provided $105,259.42, and the Government contributed a like amount, making a total available for the work of $210,518.84. The assessment was increased to 1½ cents per acre in 1913, as it was found that on the former basis the necessary improvements could not be made. For the first two years the fund met all demands, but the extremely bad fire season of 1914 necessitated the advancing of $143,000 by the provincial treasury. Economies effected in 1915 and 1916, however, have made it possible to repay the treasury the 1914 loan. Thus, in times of extreme danger, the administration is not limited to the amount available from the fund, since the Government is prepared to advance the necessary money to cope with the situation, as it did in 1914.

After making allowance for extreme hazards, due to climatic conditions, the effectiveness of a forest protection service can be judged by the relative expenditure for improvements and patrol, as compared with those for fighting fires. The statement for 1913 to 1916 is as follows :

	Fiscal years			
	1913-14	1914-15	1915-16	1916-17
Patrol	$217,093	$228,352	$157,432	$143,202.75
Improvements	104,000	31,385	5,151	4,227.65
Fires	9,600	143,461	19,449	8,774.97
Totals	$330,693	$403,198	$182,032	$156,205.37

The expenditure in the various forest districts in 1916 is fairly typical. Only about one-third of the fund is spent in the three Coast districts (Prince Rupert, Island and Vancouver), notwithstanding that these districts contribute considerably over one-half of the timber-holders' share of the fund.

FOREST PROTECTION EXPENDITURE BY DISTRICTS FOR FISCAL YEAR 1916–17

Forest district	Patrol	Improvements	Fires	Total
Headquarters	$ 2,103.18	....	....	$ 2,103.18
Cranbrook	12,836.99	$ 752.93	$ 77.65	13,667.57
Fort George	24,160.84	822.73	2,361.20	27,344.77
Hazelton	9,729.81	408.87	373.12	10,511.80
Island	12,052.05	33.00	242.28	12,327.33
Kamloops	12,063.81	30.47	39.35	12,133.63
Lillooet	6,658.26	70.40	4.65	6,733.31
Nelson	16,252.38	193.87	149.50	16,595.75
Prince Rupert	7,796.60	....	382.44	8,179.04
Vancouver	31,877.65	997.96	3,537.71	36,413.32
Vernon	8,719.71	437.63	43.45	9,200.79
	$144,251 28	$3,747.86	$7,211.35	$155,210.49

*See page 98, for definitions of 'timber-land.'

LOGGING BY DONKEY ENGINE, POWELL LAKE

LOGGING RAILWAY, COURTENAY, VANCOUVER ISLAND

The following table shows what has been accomplished in the way of permanent improvements during the four years, 1913 to 1916, inclusive :

	No.	Miles	Cost	Cost per mile or unit
Horse-trails	175	1,806·55	$54,925.72	$30.40
Foot-trails	31	201·00	4,452.09	22.15
Bridges	2	....	100.00	50.00
Telephone lines	24	492·7	34,918.39	70.87
Cabins	38	....	6,380.61	167.91
Boat-houses and caches	25	....	2,718.59	108.74
Launches, boats and canoes	74	....	40,533.48	547.75
Fencing ranger-station pastures	12	....	1,078.84	89.90
Total			$145,107.72	

Forest Fire Laws

To be effective, a forest protection service must be supported by comprehensive legal authority, a sympathetic public sentiment, and close co-operation of all the allied interests. The full text of the law governing fire protection will be found in Part XI of the British Columbia Forest Act. The most important features of this act may, however, be briefly discussed here.

Between May 1st and September 15th, a close season is established for setting fires for the purpose of clearing in or near slashings or timber, without a permit from the resident forest officer. The Governor in Council may extend the close season by proclamation. Permits to burn are granted at the discretion of the forest officer in charge, and the Lieutenant-Governor, by order in council, may prohibit the issuing of permits, and the setting of fires thereunder, in any portion of the province for such period as he may think fit.

During the close season every person who throws or drops any burning match, ashes of a pipe, lighted cigarette or cigar, or any other burning substance, or who uses explosives in any form, shall completely extinguish the fire of such match, ashes of a pipe or other burning substance before leaving the spot, and any fire thereby caused.

Railways

Recognizing that the construction and operation of railways presents a serious fire hazard, the laws in regard thereto are very stringent. The Minister of Lands is empowered to order any provincially-chartered railway company to provide such patrolmen to follow the trains and extinguish fires as he may deem necessary. If the company fails to comply, the Minister may employ men to do it, and collect the cost from the company. Fires within 200 feet of the right-of-way of any provincially-chartered railway are presumed to have been caused by the company, and all expenses incurred in preventing the spread of such fires and extinguishing them must be paid by the company. If it can be proved, however, that the fire was not caused by the company or its employees, the company is entitled to a refund from the person responsible, or from the Crown, for the money so expended. The burden of proof has been thus put on the railway company, and it has been effective in securing the assistance of the railways in reducing the fire losses.

On new lines, the right-of-way must be cleared of inflammable material before trains are operated. Special fire wardens may be appointed to supervise railway construction, and the company or contractors must furnish the men necessary for fire fighting. The expense incident to the carrying out of this work is to be borne by the company.

The railway company is liable to a fine, not exceeding $1,000, for every case in which a fire is started by sparks or hot or burning material from a railway locomotive or carriage, whether the fire begins outside the right-of-way or spreads therefrom to adjoining land. It is considered as sufficient defense, however, if it can be shown that the company has installed on its locomotives the best available modern appliances for preventing the escape of sparks or burning material, that the company or its employees have not been negligent, and that an efficient and properly equipped staff of wardens has been employed.

The foregoing provincial legislation applies, as noted, only to provincially-chartered railways, which have not been declared works for the general advantage of Canada. The only steam passenger railways coming under this classification at present are the Pacific Great Eastern, the Morrissey, Fernie and Michel, and the Eastern British Columbia railways. The remainder of the passenger railway mileage of the province, comprising much the greater portion, is subject to the jurisdiction of the Board of Railway Commissioners for Canada. The Board has paid considerable attention to the matter of railway fire protection, and has organized a Fire Inspection Department to supervise the enforcement of the provisions of general order No. 107, and of the fire protection requirements of the Railway Act. The requirements relative to railway fire protection are briefly as follows :*

(1) Rights-of-ways must be maintained free from all unnecessary combustible matter.

(2) Efficient spark arresters must be maintained on all coal-burning locomotives.

(3) The dumping of fire, live coals and ashes upon the right-of way, unless extinguished immediately, is prohibited.

(4) The use of lignite coal as locomotive fuel is prohibited, on account of fire danger from sparks.

(5) Officers of the Fire Inspection Department are authorized to prohibit the burning of debris upon the right-of-way during exceptionally dry periods.

(6) The Chief Fire Inspector is authorized to prescribe the establishment of special fire patrols by railway companies through forest sections. A large number of such patrols have been maintained in British Columbia, with excellent results.

(7) Railway companies are required to instruct sectionmen, agents, contractors, trainmen, and other regular employees, relative to the reporting and extinguishing of fires burning upon or near the right-of-way. The company is made responsible for the extinguishing of all fires occurring within 300 feet of

*For full details of the railway fire protection work of the Board, see *Forest Protection in Canada, 1913-1914*, Part I ; published by the Commission of Conservation.

the track, unless proof shall be furnished that such were not caused by the railway.

The fire protection work of the railway companies is supervised by the field staff of the Fire Inspection Department of the Board. This staff is not a special set of men employed by the Board, but consists, in British Columbia, of selected officials and employees of the Provincial Forest Branch and the Dominion Forestry Branch, who include the railway fire inspection work as a part of their regular duties. Each such official or employee is under appointment as an officer of the Board, in accordance with the co-operative arrangement established immediately following the issuance of the Board's fire regulations in 1912. This plan has worked out admirably, and the railway companies have, with few exceptions, co-operated efficiently, with the result that the fire loss due to railway causes has decreased to a remarkable extent.

On nearly 1,600 miles of railway in British Columbia, oil has been adopted as locomotive fuel. This action has been taken voluntarily and purely as a business measure by the railways concerned, and its use has resulted in very materially decreasing the fire danger along portions of the Canadian Pacific and Great Northern railways, and along the Esquimalt and Nanaimo, Grand Trunk Pacific, and Pacific Great Eastern railways.

Logging Railways

Under the Provincial Forest Act, logging and other railways not chartered as common carriers are required to clear away all debris along their tracks and to provide for patrol when ordered so to do. To prevent the escape of fire, watchmen must be kept on duty at any stationary or portable engine located in or near the forest for at least two hours after it has been shut down. Unless using oil for fuel, all locomotives and other engines used in the woods and on steamboats operated on lakes and rivers must be equipped with adequate spark arresters. Wood waste from mills must be burned in properly equipped burners. Tools, hose, etc., for fire fighting must be kept in proximity to any engine operating in the forest.

Logging Slash

The Minister, or the Forest Board, has power to declare any inflammable material, such as logging slash, which endangers life or property, a public nuisance, and can order its removal. Where the presence of debris endangers the safety of a forest, the owner or occupier of the land can be ordered to cut down dead trees and stubs within, and establish a safe fire-line around, the areas covered by the debris. Cleared fire-guards must also be maintained about every camp, mine, sawmill, portable or stationary engine using any fuel, other than oil, located within a quarter-mile of any forest.

Assistance in Fire Fighting

When a fire occurs, except under a permit, on any land on which logging or other operations are being conducted, the operator must supply as many of his employees as are required to fight the fire. If the land in question is Crown-granted timber-land, or is held under timber or pulp lease or license in respect to which a contribution to the forest protection fund is made, and, if the fire is reported promptly and accounts for fighting it are submitted within 15 days after it has been brought under control, half of the expense is borne by the fund and half by the operator; other-

wise, all must be paid by the operator. The act does not limit or interfere with the right of any person to bring civil action for damage occasioned by fire.

The penalties imposed for violation of the provisions of the act, unless otherwise stipulated, shall be not less than $50 or more than $300, and in default of payment, imprisonment, with or without hard labour, for a period not exceeding nine months.

From the preceding brief summary, it will be seen that the law respecting forest fires covers the situation adequately without being so drastic as to be unworkable.

Permits to Set Fires

The most important feature of the forest fire law is, perhaps, the system of issuing permits for setting fires. Prior to its passage the settlers were accustomed to burn their slash when they were ready, which was usually in the driest and most dangerous period, and it was with some difficulty that the law in this respect was enforced. The willingness of the rangers, by advice and instruction, to assist the settlers in their clearing operations, and then making it plain that permits were refused only when the conditions were such that burning would constitute a grave danger to their own and to other people's property, overcame much of the opposition. Wilful disobedience of the law is vigorously prosecuted, and, in most cases, convictions have been secured. One of the most important advantages of the permit system is that it brings to the attention of the ranger the sources of danger, enabling him to watch them more carefully. Practically the only criticism of the system has been that the rangers, whose positions depended to some extent upon local support, were liable to grant permits in unsuitable times. With the adoption of civil service regulations in the appointment of the rangers, however, this condition has presumably been obviated.

Method of Appointing Rangers

Ever since forest protection service became an organized institution, those who had the welfare of the forests at heart have endeavoured to free them from all local and political influences. The success of a forest protective service depends primarily on the men in the field. If they are incompetent or are under obligation to any influences outside of the organization, whether it be to a political party or local friends, the efficiency of the organization is bound to suffer. It has also been urged in British Columbia that, since the timber-owners directly contribute one-half of the cost of maintaining the provincial forest protective service, they should have a voice in the administration of it.

Forest Protection Boards

The British Columbia Government was the first in Canada to adopt these reforms. In the spring of 1917, two Forest Protection boards were appointed, one for the Coast and one for the Interior. On each of these boards the timber-owners and operators are represented by two members. The Government is represented on each of the boards by three members, consisting of the Deputy Minister of Lands (chairman), the Chief Forester and the Assistant Forester in charge of protection. All matters concerning the administration of the forest protection fund come under the jurisdiction of these boards. This co-operation between

the Government and the timber-owners will do much to ensure public confidence and assistance.

The adoption of civil service regulations in the selection of the field force is also a most important forward step. Hereafter, assistant forest rangers are to be selected by competitive examination. Before being allowed to take the examination, applicants are required to furnish very complete information respecting their physical condition and previous experience. No persons other than British subjects are permitted to take the examination, and returned soldiers with the necessary qualifications will be given preference. Assistant forest rangers are engaged for six months a year, and are re-engaged for six months in each of the following years while their services are satisfactory. There is offered, also, the prospect of advancement on merit to the permanent forest service as occasion offers. It is confidently expected that, by this method, a much superior class of men, having a permanent interest in the work, will be secured, and that fewer men will be necessary to accomplish the same result.

Public Sentiment

Public interest in forest protection in the last ten years has greatly increased. The Commission of Inquiry on Timber and Forestry had much to do with this, but it remained for the Forest Branch to crystallize the interest into the practical application of care and thoughtfulness in the handling of fire in the woods. One of the chief methods adopted in the educational campaign conducted by the Forest Branch was that of posting conspicuous and attractive notices along roads and trails, at camping sites and in all logging, mining, railway or other camps, also in schools, churches, rural post offices and other places where sportsmen, settlers or workers in the forest congregate. These posters appeal to the intelligence and business instincts rather than to fear of the law, although they also supply information in regard to the forest fire laws. Though very encouraging results have been achieved, there is need to continue and enlarge the scope of this educational work. Travellers' and campers' fires, in 1915, formed 30 per cent of the total number. In spite of the fact that this is the least excusable of all causes of forest fire, it is nearly always the most prevalent.

Since the average area patrolled by each guard and patrolman is nearly 750,000 acres, it is impossible for them to detect every fire at its inception. Through the co-operation of the lumbermen and others employed in the woods in promptly reporting fires to the nearest ranger or to the district forester, however, it has been possible to reach many fires while they were yet controllable. In 1915, twenty-six patrolmen were employed by private timber owners, and these assisted the Forest Branch very materially. The Dominion Meteorological Service has proved extremely helpful in forecasting periods of great hazard, and apprising the Forest Branch of approaching relief in the form of cooler weather and rain.

The forest officers in the southern portion of the province and those of the adjoining national forests in the United States co-operate, one reporting any fires observed in the territory of the other, and, if necessary, taking charge of the preliminary control measures. A similar arrangement exists between the Provincial and Dominion authorities along the boundary of the Railway Belt.

Logging Debris

Disposal of the debris resulting from logging operations has been discussed among lumbermen and foresters for many years. The advantage of removing the slash is unquestionable, but the feasibility, from a financial standpoint, is still a matter of doubt in some forest regions. Undoubtedly, the slash produced in the logging of the forests on the Pacific coast is the worst on the continent. The heavy stands of timber, and the immense size of the individual trees, result in a tremendous amount of waste wood being left on the ground. The unused portions of the Douglas fir and cedar trunks are frequently from two to three feet in diameter, and the branches would be considered good-sized trees in some places. In the felling of the large trees and the hauling of the logs through the woods by donkey engines, the destruction of large numbers of the smaller trees is inevitable. The climatic conditions and the nature of some woods, especially cedar, are such that the wood on the ground decays very slowly. As a result, even in the virgin woods, there is a very large amount of sound fallen timber. Dead stubs also remain standing for many years and present a very effective means of spreading fire. After all the timber which is saleable at the present time has been removed, there remains on the ground usually from 25 to 50 cords of wood per acre, which forms an almost continuous brush heap several feet deep. The removal of the forest canopy allows this debris to dry out and become a veritable fire trap.

Broadcast Burning

Fortunately, the very extensiveness of the slash facilitates its removal. Broadcast burning can, as a rule, be accomplished without the trouble and expense of piling. Owing to the large size of the pieces, piling by hand is practically impossible, and, with wood values as low as at present, using horses or machinery would be too expensive.

Though the Forest Act requires operators to dispose of their slash, it has not been generally enforced, except on timber-sales, where a clause, explicitly requiring it, has been inserted in the contract. The lumbermen have found, however, that it is in their own interest to burn over their cuttings, and that, if done early in the spring before the ground dries out under the standing timber, or in the autumn, after the first rains, the cost of the work is comparatively small. The protection which the slash burning affords the green timber adjoining, as well as their logging equipment, more than compensates for the trouble and expense of securing a burn. This is particularly true of the larger operators, who have a greater interest in the protection of their holdings than the small operators, who own little or no timber. Most of the large operators, the number of which is steadily growing, are consistently clearing up their logged-off lands in this manner. It is more difficult, however, to get the small operators to adopt this measure, since their stake in the forest is small, and, if fire destroys the timber they are working, they can easily move to other locations.

The stands in the interior, or mountain section, of the province are lighter and the trees are smaller than on the coast. As a result, the slash is lighter and is more difficult to burn successfully without piling. A number of experiments, both in broadcast burning and piling before burning, in this portion

of the province indicate that, under certain conditions, both methods are feasible. There is need, however, of greater effort being made in this direction, as, over large areas, slashings have been accumulating for years and are a constant menace to the surrounding green timber.*

Slash burning is advisable also for the improvement of conditions favourable to forest reproduction and for the destruction of injurious insects and fungi. In the standing forests, the shade is so dense that the light-demanding species, such as Douglas fir and pine, and, to a lesser extent, cedar, are not successfully reproduced, but the less valuable hemlock and balsam, which are shade enduring, become established. With the removal of the larger trees, the succeeding crop is naturally of the inferior species. If the slash is burned, and with it the less desirable young growth, a good natural reproduction of Douglas fir, red cedar and white pine is generally secured, providing the necessary seed trees are or have been present.†

The most injurious insects in British Columbia are the bark-beetles and wood-borers, which can be destroyed only by logging and subsequent burning of the slash. At present, the western yellow pine, over large areas in the southern interior portion of the province, is being killed by bark-beetles, while, on the coast, the red cedar is being seriously injured by a wood-borer. The only measure of control that is practicable in either case is the removal of the affected trees. The trunks of the affected trees are usually sound and can be sawn, but the limbs and tops must be burned to destroy the insects.‡

Decaying debris also provides an excellent place for the propagation of wood-destroying fungi, and the burning of the slash would help materially in preventing the spread of fungus diseases.

The *Report of the Forest Branch, 1915*, contains the following comment on slash disposal :

"Notwithstanding adverse financial conditions, considerable areas of logging-slash were disposed of by logging operators on their own initiative. In most cases forest officers rendered such assistance as was possible, as in all districts it is the settled policy to assist and encourage slash-burning. Numerous areas of slash were thus burned, of which full records are not available. In no instance did a fire thus set to clean up logging-slash spread and do any damage. Without exception, all operators who have tried slash-burning are so well satisfied with the results obtained that more will be burned each year. The danger appears to be less than was generally expected, and the cost is moderate, when reckoned on a per M. basis on the amount of timber cut from the area. The practice of slash-burning is certain to increase steadily, depending on financial conditions surrounding the lumber industry."

Fire Damage

Forest fire statistics are perhaps harder to compile, and are less reliable when compiled, than any other forestry data. There are several reasons for this. In the first place, large numbers of fires are never seen by the forestry

*See *Forest Protection in Canada, 1913-1914, Part III*, published by Commission of Conservation.

†See *Forest Protection in Canada, 1913-1914, Part V.*

‡See Chapter on Forest Insects.

officials, and are, therefore, not reported. In the second place, a ranger, during the fire season, has little time to make a detailed appraisal of the damage done. Thirdly, the ordinary ranger is not qualified, as yet, to make a satisfactory report from the viewpoint of the forester. The fourth, and most potent reason, is that proper standards have not yet been adopted for estimating the damage done. Most forest services attempt to collect forest fire statistics and some, notably the Dominion Forestry Branch, have developed good systems, but the lack of co-ordination between the various services renders comparisons impossible. Little definite information concerning current fire losses is therefore available.

One important omission in most of the reports of damage is that of the destruction of the young growth. The general attitude, even of the forest rangers, is that the 'brush' is of no value until it reaches log size although it may represent the growth of fifty years.

Where the land is valuable for agriculture, and will be used for that purpose, the destruction of the young growth is a gain rather than a loss. But on absolute forest land, the loss of even young seedlings can be expressed in terms of value. The future value of stumpage is unknown, but, if the history of other forest regions is any criterion for British Columbia, the increment in value will at least take care of the cost of protection, which at present amounts to about three cents per acre per annum. Yield tables are not available, but the average rate of growth in any region can be estimated with a degree of safety, from the young merchantable stands which can usually be found in any locality. The present stumpage value, including the sale price of private timber and the royalty charges, is generally known for any district. The age of the young stand destroyed can easily be obtained by counting the number of annual rings at the base of the trees.

With these three factors, an estimate of the value of a young stand can be arrived at. For example, if the stand is on the coast and is composed of Douglas fir, red cedar and hemlock of average quality, it can be assumed with safety that, in 100 years, a merchantable stand of 20,000 feet per acre would be produced in a well stocked second growth. The average annual growth would therefore be 200 feet.* If the present sale value of mature timber in the vicinity is 75 cents per M., and the royalty due the Government averages 75 cents, the stumpage value is \$1.50 per M. A ten-year-old stand is therefore, worth $\frac{200 \text{ x } \$1.50}{1{,}000} \text{ x } 10 = \$3.00$ per acre. The reproduction being natural, represents no capital expenditure, and, therefore, it is safe to say that, if the value of the young growth had been thus conservatively estimated, and had been included in the reports of damage done by fires in Canada in the last few years, the figures would have been appalling.

One of the greatest difficulties in connection with the appraisal of fire losses for young growth is the inability of the rangers to appreciate the value of the immature stands. To overcome this difficulty, the Dominion Forestry

*This figure is undoubtedly considerably below the average growth. In Washington, stands 40 years old have been found to have produced an average of 1,000 b.f. per annum.

Branch has assigned arbitrary values for certain kinds of reproduction. Upon these values, the rangers base their reports of damage. The following instructions are printed on the forms used for reporting fires :

"In preparing the statement of the damage done by fire, enter approximate values, at least of the damage done to all classes of areas burned over.

"In valuing the damage to timber that is killed by the fire, there should be considered the probability of the timber being harvested before it becomes unmerchantable. If there is no such definite probability, the value of the damage will be the full stumpage value of the timber. If there is a definite probability that the timber will be harvested, the value of the damage will be the reduction in stumpage value due to the timber having been fire-killed.

"In stands where the timber is not killed but is damaged by the fire, the value of the damage will be the reduction in the stumpage of the timber caused by the fire. If there is no probability of the timber being cut in a short time, the full value of the timber likely to be lost should be included in the damage.

"'Young growth' includes all timber too small to be manufactured, or made use of, and also includes seedlings and reproduction at any age from one year up. Young growth of pine, spruce, etc., up to an age of twenty-five years, should, where the area is entirely covered with young growth, be valued at a minimum of $5 per acre, and poplar at $3 per acre. Young growth from twenty-five to fifty years of age should be valued at about $10 per acre for pine, spruce, etc., and $6 per acre for poplar. Young growth that has not quite reached merchantable size should be valued at figures intermediate between the values given above and the value of mature stands of the same species.

"The above values for young growth apply to areas that are well stocked with young growth, which, when mature, would yield 8,000 to 10,000 feet, board measure, per acre, or 20 to 30 cords. For poorer areas, lower values should be used.

"The age of young trees may be estimated by counting the number of rings across the stumps of trees that may be cut down for the purpose, or, for evergreen trees, by counting the whorls of branches along the main stem from the tip of a tree to the base. The age may also be estimated roughly from the average height of the trees, as follows: Pine, 10 years, 5 ft. ; 25 years, 20 ft. ; 50 years, 40 ft. Spruce, 10 years, 5 ft. ; 25 years, 15 ft. ; 50 years, 25 ft. Poplar, 10 years, 10 ft. ; 25 years, 25 ft. ; 50 years, 50 ft."

The Fire Inspection Department of the Railway Commission issues the following instructions in this connection to their inspectors :

"Some allowance should be made for young growth, but this must be comparatively low, on account of present low stumpage prices. Where natural reproduction may reasonably be expected to come in after the fire, the estimate of damage for this classification would consist merely of the cost of protection, with accumulated interest, for the number of years required to establish a stand equally as good as that destroyed by the fire in question. Under some circumstances, it will be allowable to figure the damage as the cost of replacement by artificial planting, with accumulated interest for the required number of years, but under existing conditions this procedure will be the exception rather than the rule. It should, however, be understood that the tendency will be in this direction, in cases where natural reproduction can not be depended upon.

"Where the local inspector is in doubt as to what values to apply, especially in the case of young growth, he should report the conditions fully on Fire Report form, so that the estimate of value may be checked by the superior officer.

"In the case of destruction of forest products in process of manufacture (as saw-logs, ties, poles, pulpwood, etc.), the actual value at the place where burned should be reported. In general, this will be equivalent to stumpage value plus the value of all work done in connection with the partial or total process of cutting, manufacture and transportation."

The British Columbia Forest Branch has not, as yet, given enough attention to this destruction of the growing forests, and the values assigned for the areas burned over seem very low, even after allowance is made for the fact that no value is attached to unmerchantable timber on agricultural lands.*

There seems to be a mistaken tendency among forest services to unduly minimize the damage done by forest fires. The effect of this is to lull the public into a false sense of security, whereas, in fact, increased expenditure on forest protection is more than justified.

The Provincial Forest Branch reports the damage done by forest fires during the last seven years as varying from $622,915 in 1910 to $75,875 in 1916. The following table gives, in condensed form, the fire statistics for these years. Details are given as to the nature and extent of the damage in each forest district.

DAMAGE CAUSED BY FOREST FIRES IN BRITISH COLUMBIA, 1910-1916

	1910	1911	1912	1913	1914	1915	1916
Total number of fires	1,184	331	347	578	1,832	1,031	864
Total area burned over (acres)	218,388	....	160,000	10,270	355,124	244,189	161,288
Standing timber destroyed or damaged (M.b.f.)	130,650	3,570	200,000	3,845	102,804	187,250	50,415
Amount salvable (M.b.f.) †	....	....	....	....	....	43,030	2,757
Damage to forest	$193,976	Not given	$200,000	$4,387	$72,057	$108,873	$48,913
Damage to other forms of property	$435,939	$47,000	$113,273	$13,967	$364,475	$57,774	$26,962
Total damage	$629,915	....	$313,273	$18,354	$436,532	$166,647‡	$75,875‡

Causes of forest fires on provincial lands in British Columbia during the years 1910–1916 were as follows :

Causes	1910	1911	1912	1913	1914	1915	1916
Campers and travellers (including smokers, Indians, prospectors, hunters, tramps, etc.)	188	126	51	195	487	305	268
Unknown	374	126	149	104	367	160	148
Operation of railways (common carriers only)	272	31	34	110	361	82	121
Lightning	103	1	23	34	169	100	67
Brush-burning to clear farm land, etc	184	14	47	26	164	267	148
Railway construction	....	8	11	62	98	17	...
Miscellaneous (known causes)	....	3	6	7	83	24	19
Industrial operations (chiefly logging)	63	14	17	24	50	28	59
Incendiary	...	...	...	7	42	28	22
Public-road construction	...	8	9	9	11	20	12
Totals	1,184	331	347	578	1,832	1,031	864

*See *British Columbia Forest Branch Reports.*

†Amount salvable not reported for 1910-1914.

‡From these totals the salvage has not been deducted. Salvage is a very uncertain quantity, and may or may not be realized.

LOGGING SLASH BURNED, PREPARATORY TO CLEARING. COURTENAY, VANCOUVER ISLAND

CLEARED LAND (OAK ON LEFT), COURTENAY, VANCOUVER ISLAND

As the number of fires from 'unknown' causes decreases, the proportion known to be caused by campers and travellers increases. The large number of fires caused by campers and by settlers indicates the necessity for increased publicity work, and of more drastic legal action against careless or wilfully negligent offenders.

The loss occasioned by forest fires is not confined to the damage to property, but the expense of fighting them is an important item. The records of the Forest Branch show that, during the seven years, 1910-16, $362,318 has been expended in fire-fighting. Approximately 64 per cent of the fires was extinguished without expense, but the remainder cost, on the average, $163 per fire to extinguish or control. During the three years, 1914-16, 69 per cent of the fires originated on alienated lands, such as pre-emptions, purchased lands or Crown-granted lands, which are not classified as timber-lands * and which do not contribute to the forest protection fund, and only 31 per cent on vacant Crown lands or lands held under timber lease, timber license, or Crown-granted timber lands which maintain the fund.

CLASSIFICATION OF FIRES BY PLACE OF ORIGIN AND COST OF FIRE-FIGHTING

	Total number of fires	Originated on vacant Crown lands and lands paying F. P. tax	Originated on alienated lands not paying F. P. tax	Extinguished without cost		Cost money to extinguish		Total cost of fire fighting	Average cost per fire
				Number	Per cent	Number	Per cent		
1910	1,184	....	....	615	52	569	48	$140,000	$246
1911	331	....	....	199	60	132	40	14,344	109
1912	347	....	....	113	33	234	67	29,879	128
1913	578	....	....	420	73	158	27	9,600	61
1914	1,832	599	1,233	1,193	65	639	35	143,461	224
1915	1,031	341	690	714	69	317	31	19,449	61
1916	864	209	655	693	80	171	20	5,585	32
	6,167	31%	69%		64		36	$362,318	$163

The success of the burning permit system, as a means of controlling fires, has been demonstrated by the records, as shown in the following table. These show that settlers are by far the worst offenders, both in regard to setting fire without permits and in allowing them to get beyond control.

BURNING PERMITS FOR CLEARING, 1916

Purpose	Number of permits issued	Area burned over (acres)	Number of fires escaped control	Number of fires set without permit
Agricultural land	6,901	20,344	51	61
Logging slash	150	2,332	..	1
Railway right-of-way	93	2,157	..	1
Public roads	112	161 miles	..	2
Total, 1916	7,256	24,833†	51	65
Total, 1915	9,515	52,475†	55	66
Total, 1914	11,523	52,935†	128	80

*Timber-land defined, p. 98, chap. IV.
†Not including public roads.

Collection of Forest Revenue

A large proportion of the forest administration in British Columbia is directly concerned in the collection of revenue. Rentals are payable only at the head office in Victoria, but the royalty, stumpage, export tax and manufacturing tax are collected by the district foresters. A most equitable and efficient system has been developed in this department of the service, with the result that there is perhaps less evasion of payment, and less dissatisfaction on the part of the contributors, than in the collection of any other form of revenue. This condition is attributable very largely to the method in measuring the timber cut.

One of the most difficult problems to solve in connection with the lumber industry in British Columbia has been the measurement of timber in the form of logs, bolts or ties. Most of the logging, especially on the Coast, is done independently of the mills, which depend to a large extent on buying their supplies. In the fixing of a scale or measurement, therefore, three interests have to be considered, *viz.*, the logger, the millman and the Government. Log rules of very many kinds, and giving widely varying results, are in use in different parts of the American continent, but very few of them are applicable to the large-sized timber found on the Pacific coast.* In Canada, the Doyle rule has perhaps been most generally used. On the Coast a combination of the Doyle and Scribner rules was followed until the British Columbia rule was devised and accepted in 1892. The Doyle-Scribner rule read up to a diameter of only 44 inches, and the contents of logs of larger sizes were guessed at. This method, as might be expected, gave rise to much dissatisfaction and considerable litigation. In 1891, the Chief Commissioner of Lands and Works appointed a committee, composed of Andrew Haslam, M.P., Nanaimo ; R. H. Alexander, representing the sawmills ; and Mr. King, representing the loggers, to devise a rule which would, as nearly as possible, give a just measurement for all concerned. Mr. Haslam presented a formula, illustrated by a series of diagrams and practical results in sawing, which, in the opinion of the Committee, would give satisfaction, and it was adopted in 1892. Its use was not enforced, however, till 1902, when the Legislature provided, in the Timber Measurement Act, for the appointment of an official supervisor of scalers and official scalers. The new scale was adopted, however, only for that portion of the province lying west of the Coast mountains. The millmen in the interior objected to its use, on the ground that it was too high for small-sized logs, such as they handled. In 1915, this objection was overcome, and the use of the British Columbia rule was made obligatory throughout the province. The formula on which this rule is based is as follows :

British Columbia Rule Formula

Deduct one and one-half inches from the mean diameter in inches at the small end of the log for slab and kerf; square the result and multiply by .7854 to find the area; deduct $\frac{3}{10}$; divide by 12 to bring to board measure, and multiply by the length of the log in feet.†

*An interesting comparison of the results obtained from the more important log rules in use is published in Table 1, *Woodsman's Handbook, U.S. Forest Service Bulletin No. 36*.

†See condensed scale in Appendix III.

The British Columbia rule gives somewhat higher readings than the Doyle rule for logs up to 22 inches in diameter, and increasingly lower figures for logs over that size. Compared with the Spaulding rule, which is generally used in the Pacific States, it is slightly higher for logs up to 14 inches in diameter and, on the average, about 5 per cent lower for logs over that diameter.

The following comparison of the three scales on logs 16 feet in length illustrates this difference :

Log diameter, inches	Scale, in feet, board measure		
	British Columbia	Doyle	Spaulding
10	55	36	50
20	261	256	276
30	619	657	656
40	1,129	1,296	1,185
50	1,791	2,116	1,872
60	2,606	3,136	2,704
70	3,573	4,356	....

No rule can be established which will give the exact amount in board feet that may be cut from a given log, since much depends upon the kind of machinery used and the skill of the men operating it. The experience of the last twenty years, however, has proved the British Columbia scale to be fair and equitable, and the general enforcement of its use has removed all cause of friction between vendors and purchasers of logs.

Advantages of Cubic Measure

The measurement of logs or lumber by board measure is an unnecessarily cumbersome and inaccurate method ; it would be much simpler and fairer if cubic measurement were used, as it is, almost universally, outside of Canada and the United States. By the use of cubic measure, the logger would be paid for the amount of wood he sold, and it would be to the interest of the mill operator to waste as little as possible in slabs and saw-kerf. In the case of lumber, the consumer would get the full amount of wood he pays for, and not 75 to 90 per cent, as he now does, when ¾-inch boards are sold for 1-inch. There is, of course, a disadvantage in the use of the cubic measure in that the small logs do not cut so economically per cubic foot as the larger logs. Though it is recognized that such a radical change cannot be made locally, or without due consideration it would seem that the adoption of the cubic measure would be of material advantage in the development of an export trade.

Aside from the adoption of a satisfactory rule for the entire province, British Columbia has developed a most efficient system of scaling, which, while enabling the Government to keep, for royalty purposes, an exact record of logs cut, removes all cause for difference between buyers and sellers of logs.

Prior to the passing of the Official Scalers Act in 1894, there were no authorized scalers in the Province, and the royalty was collected on the basis of reports furnished by the operators. This Act provided for the appointment of a supervisor of scalers and six official scalers, to be located in different districts throughout the province. It was the duty of these scalers, on the

request of an owner of timber which had been cut, to measure it and furnish a report.

Scaling Fees

Fees amounting to 5 cents per 1,000 feet for logs and spars, or per 200 lineal feet of piles and poles, or per cord of ties and cedar bolts, were collected for this work. A copy of the scale and the fees were forwarded to the Government. Fees were not collected, however, for scaling timber cut on lands held under lease prior to the passing of the Act in 1894. No sale, or agreement of sale, of logs or other cut timber on which a royalty was due, was enforceable unless the timber had been scaled by an official scaler, and such scales were considered the basis of sales, unless otherwise agreed upon between vendor and purchaser. Timber on which a royalty or revenue was due the Government could not be exported unless scaled by an official scaler. This Act left the matter very much at the option of the operator whether he would, or would not, employ the services of an official scaler.

Official Scale Compulsory

In 1902 the Timber Measurement Act was passed. This made it compulsory to have all timber scaled by an official scaler before being sawn. The scalers, instead of being Government employees, were licensed, the fee being $25, and were authorized to collect fees as provided for in the Act of 1894. Each mill was allowed to have a licensed scaler, but those in the employ of mills were not entitled to charge any fees. Reports of all scales made had to be sent in to the Government. This act was applicable west of the Coast mountains only. In the remainder of the province the operators employed their own scalers and furnished the Government with the returns.

In 1906, the present system was established. Its main features are, that the official scalers are employed by, and are responsible only to, the Government. They must be British subjects, and are appointed only after passing a qualifying examination. The same fees are charged as heretofore, but they are payable to the Government, and, together with the expenses incurred in making the scale, become a lien upon the timber. In the event of a vendor or a purchaser objecting to any official scaler or to his scaling, another scaler may be selected to measure the timber, the party requiring the re-scale or substitution paying the extra expense. Every scale of cut timber must be based on the official scale. No timber is allowed to be sawn on which there is any royalty or other revenue due to the province, nor may timber from any lands under provincial jurisdiction be exported, until it has been scaled by an official scaler.

Owing to the operations in the interior being so scattered, it has not been found practicable to appoint official scalers, except for the Coast region, but the Forest Act, 1912, provides for the employment of licensed scalers for the mountain sections.

Each piece of timber rafted or floated on the salt or fresh waters of the province must be marked with a registered mark. This was first required in 1890, and applied only to the Coast, but it is now in force throughout the province. Separate marks are required for each Crown-granted lot, leasehold or license.

Base map from plate of Map of Dominion of Canada, Dept. of Interior

CHAPTER VI

Forest Administration on Dominion Lands

ADMINISTRATION of the forests on Dominion lands in British Columbia is divided among three branches of the Dept. of the Interior, *viz.*, the Timber and Grazing Lands Branch, the Forestry Branch, and the Parks Branch.

Timber and Grazing Lands Branch

The Timber and Grazing Lands Branch has charge of the alienation of the timber and grazing rights, and collects the revenue from them. The jurisdiction of this branch does not extend to forest reserves or parks, except in respect to timber or grazing leases which had been granted within these reserves or parks previous to their establishment as such. Though entrusted with the enforcement of the cutting and other regulations designed to further the conservation of the forests, contained in the timber licenses, no technical staff is provided, and little, if any, attempt has been made in this direction.*

The organization consists of a head office in Ottawa, with branches, known as Crown Timber agencies, throughout the west. Those in British Columbia are situated at Revelstoke, Kamloops and New Westminster. Timber business in the Peace River Block is handled by the office at Grouard, Alta. The Crown timber agents at Revelstoke and New Westminster act as agents for the Timber and Grazing Lands Branch and, as representatives of the Forestry Branch, they are also in charge of fire protection on lands outside of the forest reserves. The advantages of combining the administrative and protective functions in the local offices are so apparent that it would seem advisable to develop the co-operation elsewhere.

Rentals and Royalty

The main revenue from the forests on Dominion lands is secured from rentals on timber berths, royalty on the timber cut and cash bonuses paid by licensees at the time of purchase. Rentals (annual license fees) for timber berths are charged at the rate of $5.00 per square mile per annum in the 'Interior' of the province (east of Yale) and 5 cents per acre per annum on the 'Coast' (west of Yale). The royalty for saw material is the same, 50 cents per M.b.f., on all Dominion lands.

Scaling

In the past, the Dominion has, unlike the province, depended practically altogether on returns submitted and sworn to by the operators, although a few scalers were employed by the Dominion for the purpose of checking the reports submitted by the loggers and millmen. Such returns are still required of all sawn lumber, timber, or any other product of timber from the berth, with the exception of slabs for

*See also "Administration of Dominion Forests." By J. H. White, in *Forest Protection in Canada, 1913-1914*, Commission of Conservation, p. 256, *et seq.*

fuel purposes or sawdust, showing the quantities manufactured, sold or disposed of, and the value thereof. A bush count is also required to be kept of all saw-logs and other timber cut upon a berth, as well as the number of pieces hauled therefrom, and the books containing these records must be duly sworn to and returned to the Dominion Timber Agent. Since August 1, 1917, however, the payment of fees is based upon the actual log scale only, scaling to be done according to the British Columbia rule. Timber cut on Railway Belt lands north and east of Yale may be scaled only by persons authorized in writing by the Minister or his appointed agent. Timber cut on Dominion lands south and west of Yale is to be scaled by a Dominion timber scaler holding a scaler's license from the British Columbia Government, and in accordance with standard methods.* A further change is now in contemplation, under which the scaling south and west of Yale would be done by a scaler holding a British Columbia scaler's license, but employed by the Department of the Interior, instead of by such men in the employ of the licensees. It is recognized that the establishment of Dominion Government scaling in the Interior would be difficult, since, throughout the Belt, the logs are, as a rule, sawn in local mills. A large force of scalers would be required for the scaling if the operations of the camps and mills were not to be unduly delayed.

Most Accessible Timber Alienated

The Dominion assumed control of the Railway Belt in 1883, and, since the lands within the Belt are all within 20 miles of the Canadian Pacific railway, which constitutes the main artery of commerce in the province, its forests have presented opportunities for both speculation and operation that much of the timber on provincial lands did not then have. The consequence has been that almost all the accessible mature timber has been alienated. The larger portion has been in private hands for some years.

The Commission of Conservation is indebted to the Timber and Grazing Lands Branch for the following statement of the revenue derived from the forests in the Railway Belt. Considerable difficulty was encountered in securing the figures for the early years, owing to the different methods of accounting followed ; where the items could not be segregated they were placed in the 'not classified' column. The totals, which, however, are fairly complete, show that, during the last 27 years, the Dominion has derived $2,232,731 from its forests in the Railway Belt.

FOREST REVENUES FROM THE RAILWAY BELT IN BRITISH COLUMBIA
COLLECTED BY THE TIMBER AND GRAZING LANDS BRANCH

Year	Timber licenses			Timber permits	Seizures	Revenue not classified	Total forest revenue
	Bonus	Rentals	Royalty				
1890–91	$ 26,322.02	$ 2,957.33	$ 6,713.35	$ 13,809.98	$ 95.89	....	$ 49,898.57
1891–92	2,014.00	5,557.84	18,039.36	7,004.77	249.28	....	32,865.25
1892–93	5,625.50	9,071.42	....	215.93	......	$ 36,946.53	51,859.38
1893–94	2,385.76	3,885.91	....	1,034.43	......	29,778.16	37,084.26
1894–95	356.87	3,345.97	....	211.09	......	21,013.25	24,927.18

*See 'Dominion Timber Regulations, 1917,' No. 26 and 27.

FOREST REVENUES (continued)

Year	Timber licenses			Timber permits	Seizures	Revenue not classified	Total forest revenue
	Bonus	Rentals	Royalty				
1895–96	$ 418.50	$ 2,588.11	....	....	......	$ 18,519.10	$ 21,525.71
1896–97	3,813.85	4,539.77	$ 686.96	....	$ 711.84	13,590.58	23,343.00
1897–98	....	3,999.21	6,268.88	$ 1,339.83	2,394.33	5,758.45	19,760.70
1898–99	....	8,541.60	16,597.79	2,129.99	1,297.20	12,426.85	40,993.43
1899–1900	3,788.50	8,552.40	13,012.96	1,779.50	555.18	....	27,688.54
1900–01	2,676.17	7,480.33	9,899.69	1,802.63	1,275.88	....	23,134.70
1901–02	7,384.75	16,364.82	29,550.21	3,014.79	1,605.10	....	57,919.67
1902–03	141,436.17	18,816.98	24,207.61	3,515.65	1,833.26	....	189,809.67
1903–04	61,557.32	14,496.16	18,801.46	1,579.78	2,265.90	....	98,700.62
1904–05	33,571.20	19,079.41	16,286.41	2,142.25	......	....	71,079.27
1905–06	41,360.44	17,371.63	18,584.73	4,823.18	342.95	....	82,482.93
1906–07	155,798.45	5,171.29	22,149.63	1,808.08	241.35	....	185,168.80
1907–08	113,264.65	27,059.81	35,961.42	7,221.40	8,621.60	....	192,128.88
1908–09	....	23,303.64	26,870.97	3,098.27	2,463.37	....	55,736.25
1909–10	9,525.00	33,957.51	70,982.78	3,683.80	8,202.14	....	126,351.23
1910–11	38,704.15	33,794.86	50,740.65	11,169.11	10,817.15	....	145,225.92
1911–12	10,050.89	34,502.07	55,574.18	15,619.23	5,629.02	....	121,375.39
1912–13	11,924.55	36,154.76	49,950.11	17,865.63	5,497.20	....	121,392.25
1913–14	22,672.37	21,813.73	45,850.41	9,716.89	3,174.36	....	103,227.76
1914–15	11,415.45	24,956.47	33,913.51	11,188.88	7,803.03	....	89,277.34
1915–16	8,057.18	21,310.99	54,144.83	16,428.71	2,565.19	....	102,506.90
1916–17	10,207.95	20,464.86	83,459.19	21,706.08	1,429.89	....	137,267.97
	$724,331.69	$429,138.88	$708,247.09	$163,909.88	$69,071.11	$138,032.92	$2,232,731.57

Expenditures of the Timber and Grazing Lands Branch in the Railway Belt are, in some instances, not separated from those in the other provinces or from those of the Dominion Lands Branch and, therefore, it is impossible to more than estimate the cost of collection of this revenue, but it is probably in the neighbourhood of $30,000 per annum.

The Forestry Branch

The Forestry Branch was established in 1899, and Mr. Elihu Stewart was appointed chief inspector of timber and forestry. Two kinds of work were undertaken, the planting of shelter belts on the prairie farms and the protection of the standing forests on Dominion lands. Both of these lines of work have developed into very important undertakings. The first forest rangers were appointed in 1901, when six were employed in the Railway Belt.

The first technical forester to be employed in Canada was Mr. Norman M. Ross, a graduate of the Ontario Agricultural College and of the Biltmore Forest School. He was appointed in 1901, and is in charge of the tree planting operations of the branch. Dr. A. H. Unwin, a trained English forester, entered the service in 1903, and was succeeded in 1904 by Roland D. Craig, F.E.

First Forest Survey

Prior to 1906, no forest reserves had been definitely set aside, though several large areas had been withdrawn from settlement and placed under the control of the Forestry Branch. A survey of the forest conditions on these reserves was commenced in 1905, to determine, not only the present timber supply, but the rate of growth, so that administrative plans might be formulated.

The passing of the Dominion Forest Reserves Act, 1906, was one of the most important events in the development of forestry in Canada. This Act segregated permanently for forest purposes twenty-one forest reserves, eight of which were in the Railway Belt.

As an indication of the recognition of the importance of protection of the forests by the Dominion Government, it may be noted that the staff of the Forestry Branch now numbers 562 members, 44 of whom are technically trained foresters. In the Railway Belt in British Columbia the staff consists of :

Inspector of forest reserves	1	
Supervisor	1	
Forest assistants	2	4
On forest reserves—		
Permanent rangers	10	
Temporary rangers	9	19
Outside forest reserves—		
Coast District		
Chief fire ranger (permanent)	1	
Temporary rangers	21	22
Salmon Arm District		
Chief fire ranger (temporary)	1	
Temporary rangers	20	21
Revelstoke District		
Chief fire ranger (permanent)	1	
Temporary rangers	17	18
Railway Fire Protection—		
Divisional fire inspectors (temporary)	2	2
Total		86

The more important lines of work being conducted by the Forestry Branch are tree planting on the prairies, collection of trade statistics relating to forest products, investigation of the properties and methods of use of forest products, exploration of the forests on Dominion lands, protection from fire of the forests in Manitoba, Saskatchewan and Alberta, and the Peace River Block and Railway Belt in British Columbia, and the administration of the forest resources.

Tree Planting

Nurseries are maintained at Indian Head and Sutherland, Sask., from which seedlings are supplied free of charge to farmers for shelter belts. Owing to the care exercised in educating the planters and to subsequent inspection, this work has been very successful. On the average, about 3,500 applicants are supplied with about 1,000 trees each per year. Many seedlings are also used for planting on the forest reserves, but, as yet, very little has been done in this direction in British Columbia.

Forest Products Investigation

Through the co-operation of the wood-using industries, the branch publishes most instructive bulletins on the consumption in Canada of such forest products as lumber, lath, shingles, pulpwood, poles and cross-ties. A laboratory for the study of the physical and chemical properties of woods and their industrial uses is maintained by the Forestry Branch at McGill University, Montreal. The laboratory is equipped with machinery for testing the strength of wood and with a complete paper-making machine. *Bulletin No. 59, Canadian Woods for Structural Timbers*, is of special interest in connection with British Columbia woods.

Exploration

Reconnaissance surveys have been conducted over a considerable area of both reserved and unreserved land, but there are still immense tracts in the north concerning which there is practically no information. One of the principal objects of these surveys is to classify the land according to its suitability for agricultural or forest purposes, and thus direct settlement to suitable regions. Estimation of the present stand of merchantable timber and study of conditions in regard to future crops are important features of this work. From the information gathered in these surveys, intelligent plans for the protection and administration of the forests can be formulated. The Director of Forestry, in his report for 1914–1915, says :

"Reconnaissance surveys have been continued, so that now fairly accurate information has been obtained of the stand of timber and the agricultural possibilities of the lands in the Railway Belt in the province of British Columbia, and a strip approximately 75 miles in width to the north of the prairies in Manitoba, Saskatchewan, and Alberta. The information obtained from these surveys demonstrates clearly that there are large areas in the districts covered that are not fitted for agriculture, and in which the forest will be one of the most important agencies for the development of industries, of population, and of such measures of agriculture or grazing as may be possible. The proportion of mature timber found is comparatively small, and the loss by fire is appalling. If it were fully realized what immense tracts have been swept in this way, what a splendid natural reproduction there is in most cases, how real and imminent the present danger of fire is, and how costly the reforestation by planting at a rate of $7 to $10 per acre of the millions of acres of forest land would be, the strongest efforts would be put forth to save a gift of nature which will be a great factor in building up homes on the prairies."

Land Classification

Land which, upon examination, is found to be suitable for forest purposes only, should be permanently reserved and placed under forestry management. Permanency is essential in the practice of forestry. The crop takes many years, often a century, to mature, and the work of years may be wasted by a vacillating policy. Respect for the regulations of the reserves by squatters and other violators of the laws can be secured only when it is definitely understood that time will not change the attitude of the administration.

Forest Reserves

The Forestry Branch has control of the forest reserves as to land, timber and grazing, except where rights to such were granted prior to the creation of the reserve. In British Columbia the reserves unfortunately include little timber of present commercial value, and nearly all of that is privately held under timber licenses, over which the Forestry Branch has no control. In some of the reserves, such as those in the Kamloops district, the stands are naturally light, due to the dry climate, but, throughout the greater portion of the 1,759,618 acres reserved, though fires have destroyed the original stands, young forests which need protection exist in varying stages of development. The administration of these reserves, therefore, consists chiefly in protecting the growing forests from fire, the regulation of grazing, and the sale of small amounts of timber by the permit system. The forest reserves in the Prairie Provinces supply large

amounts of timber for building purposes and fuel to the settlers on the treeless plains in the vicinity, but, in British Columbia, the settlers, as a rule, do not need to draw from the reserves.

Forest Protection on Dominion Lands

The Forestry Branch is also charged with protection of the lands outside of the forest reserves and, though the officers co-operate, the field staffs on forest reserves and on the lands outside the forest reserves are kept distinct. Part of the cost of the fire protection service is paid by the license holders on the basis of one-half of the acreage cost for the district in which the berths are situated. The Dominion Government defrays the total expense for its own and Crown-granted lands and one-half for the licensed lands.

Forestry Branch Revenue

Since the revenue from the timber licenses and fire protection contributions from licensees are credited to the Timber and Grazing Lands Branch, the revenue of the Forestry Branch is necessarily small. The total revenue collected by the Forestry Branch for the last few years has averaged about $38,000 per annum, of which only from $200 to $300 was received from British Columbia.

REVENUE OF THE FORESTRY BRANCH DERIVED FROM THE FOREST RESERVES IN THE RAILWAY BELT

	1912–13	1913–14	1914–15	1915–16	1916–17
Timber permits and sales royalty (Permit fees and dues)	$ 0.75	$ 39.38	$ 69.10	$234.45	$139.54
Special uses	......	......	34.25	18.00	35.50
Lease rentals (summer resort lots, etc.)	124.60	164.27	133.40	77.40	147.40
Hay permits	12.00	20.55	13.85	14.75	12.70
Total	$137.35	$224.20	$250.60	$344.60	$335.14

The fire protection tax has yielded the following amounts during recent years :

FIRE PROTECTION TAX IN RAILWAY BELT

Year	Area in sq. miles			Rate per sq. mile	Total amount
	Licenses	Permits	Total		
1912	1,800.11	7.20	1,807.31	$4.96	$ 8,964.25
1913	1,756.53	4.55	1,761.08	5.95	10,478.42
1914	1,764.25	4.49	1,768.74	9.12	16,131.91
1915	1,758.09	4.49	1,762.58	5.43	9,570.81
1916	1,755.26	4.49	1,759.75	5.94	10,452.91

Under the provincial system, the timber owners contribute 1½ cents per acre, which provides one-half the cost of protecting the *whole of the provincial lands*, while, on the Dominion lands, they pay, on the average, but 1 cent per acre, which is only one-half the cost of protecting *their own lands*. Owners of Crown-granted timber-land within the Railway Belt, whether they be settlers, lumbermen or speculators, should be assessed for at least a share of the cost of this service.

PULP AND PAPER MILL, POWELL RIVER

BRITISH COLUMBIA SULPHITE FIBRE CO.'S PLANT, HOWE SOUND

EXPENDITURES OF THE FORESTRY BRANCH IN BRITISH COLUMBIA RAILWAY BELT

Fiscal year April 1 to March 31	In forest reserves *					On Dominion lands outside forest reserves			Total cost of forest protection
	Adminis-tration	Permanent improvement and equipment	Patrol	Fire fighting	Total expenditure on forest reserves	Permanent improvement and equipment	Patrol	Fire fighting	
1901–02	....	....	....	....	....	....	$2,117.05	$ 540.25	$ 2,657.30
1902–03	....	....	....	....	....	....	3,406.05	56.00	3,462.05
1903–04	....	....	....	....	....	....	4,387.15	....	4,387.15
1904–05	....	....	....	....	....	....	4,133.10	4,790.11	8,923.21
1905–06	....	....	....	....	....	....	6,395.89	7,169.05	13,564.94
1906–07	....	....	....	....	....	....	9,443.38	7,101.85	16,545.23
1907–08	....	....	....	....	....	....	11,831.31	2,280.98	14,112.29
1908–09	....	....	....	....	....	....	18,817.75	6,637.15	25,454.90
1909–10	$4,209.91	$ 218.81†	$ 979.55	$ 315.00	$ 5,823.27	....	27,160.50	3,993.39	36,977.16
1910–11	7,244.18	95.10†	1,211.40	included with Dom. lands	8,550.68	....	26,429.26	5,501.98	40,481.92
1911–12	6,528.99	48.91†	1,450.20	"	8,028.10	....	29,058.89	8,855.52	45,942.51
1912–13	7,389.42	1,340.42	2,592.39	nil	11,322.23	....	50,753.55	nil	62,075.78
1913–14	17,998.56	18,844.10	348.36	137.88	37,328.90	$13,037.54	55,251.04	1,117.05	106,345.53
1914–15	21,846.35	11,139.24	1,328.00	6,927.63	41,241.22	4,418.94	52,758.74	39,127.68	137,546.58
1915–16	18,181.90	26,981.69	1,596.48	59.93	46,820.00	7,515.67	53,725.06	4,600.81	112,661.54
1916–17	21,293.11	32,685.10	2,174.97	149.81	56,302.99	5,190.53	54,650.04	952.50	117,096.06

* For the years 1901 to 1909, inclusive, the expenditures on forest reserves were included with lands outside forest reserves.
† Survey only.

Expenditure

The expenditures of the Forestry Branch in British Columbia are about equally divided between administration of the forest reserves and protection of the forests outside of the reserves. It will be noted, in the following statement supplied by the Dominion Forestry Branch, that a large amount is spent each year in permanent improvements, especially in the reserves. These improvements, which have been installed during the last four years, chiefly consist of horse trails, telephone lines, ranger stations and look-out towers. Owing to the installation of the improvements, and more effective patrols, the cost of fire fighting, except in the extremely dry year of 1914, has been very low. (See table, p. 149.)

Forest Protection in Railway Belt

The following table shows the distribution of the ranger staff in the Railway Belt, and the areas covered by each, the average being 162 square miles :

	Number of rangers	Area of territory patrolled, sq. miles	Average area per ranger, sq. miles
Forest reserves	19	2,749·56	144·7
Outside reserves—			
Coast district	21	3,200	152·4
Salmon Arm district	20	3,970	198·5
Revelstoke district	17	2,520	148·2

Most of the forest fires, as one would expect, occur outside of the forest reserves. Very little logging is being done in the reserves as yet, and, as settlement is excluded, the hazard is not so great. The most dangerous months are July and August, though May is frequently a bad month.

SUMMARY OF FOREST FIRES IN THE RAILWAY BELT, SEASONS OF 1914–1916

	1914			1915			1916		
	Large	Small	Total	Large	Small	Total	Large	Small	Total
In forest reserves—									
April	..	..	..	..	..	..	..	..	..
May	1	..	1	..	..	..	..	..	..
June	..	3	3	..	..	..	..	..	..
July	4	..	4	..	..	..	..	..	..
August	7	..	7	1	2	3	1	1	2
September	3	..	3	..	..	..	..	2	2
October	..	..	..	..	..	..	1	..	1
Total	15	3	18	1	2	3	2	3	5
Outside forest reserves—									
April	1	2	3	3	1	4	..	..	..
May	10	71	81	1	65	66	1	36	37
June	2	48	50	..	65	65	5	34	39
July	21	126	147	13	101	114	..	32	32
August	93	120	213	24	112	136	5	65	70
September	16	42	58	..	50	50	3	74	77
October	1	1	2	..	..	..	2	10	12
Total	144	410	554	41	394	435	16	251	267
Grand total	159	413	572	42	396	438	18	254	272

COST OF FIGHTING FOREST FIRES IN THE RAILWAY BELT

	In forest reserves	Outside forest reserves	Total
1914	$5,458	$39,121	$44,579
1915	45	4,377	4,422
1916	103	992	1,095

The difficulty of appraising the damage done by forest fires was discussed in connection with protection on provincial lands.* The early records in the Railway Belt, as elsewhere, are of very little value. During the last few years, special efforts have been made to collect authoritative fire data, and emphasis is laid on the valuation of young growth. A serious difficulty in the way of obtaining this information is that the ordinary ranger considers it a reflection on his work if he admits material damage, notwithstanding that he may have done everything humanly possible to protect the territory. The blame, in many cases, should be charged to natural or other conditions, some of which might be remedied if attention were called to their existence.

DAMAGE BY FOREST FIRES IN THE RAILWAY BELT

	In forest reserves			Outside forest reserves			Total		
	Area, acres	M.b.f.	Cords	Area, acres	M.b.f.	Cords	Area, acres	M.b.f.	Cords
1914									
Merchantable timber	1,370	530	....	8,695	39,937	....	10,065	40,467	....
Young growth	13,680	....	....	21,238	....	....	34,918	....	....
Slash	......	....	....	12,927	....	....	12,927	....	....
Old burn, not restocking	......	....	....	7,698	....	....	7,698	....	....
Grassland	......	....	....	995	....	....	995	....	....
Other classes	......	....	....	3,617	....	....	3,617	....	....
Total	15,050	530	....	55,170	39,937	....	70,220	40,467	....
1915									
Merchantable timber	182	19	....	439	2,510	275	621	2,529	275
Young growth	182	....	30	2,156	....	....	2,338	....	30
Slash	......	....	....	11,188	....	....	11,188	....	....
Old burn, not restocking	......	....	....	1,763	....	....	1,763	....	....
Total	364	19	30	15,546	2,510	275	15,910	2,529	305
1916									
Merchantable timber	30	13	....	97	365	....	127	378	....
Young growth	25	....	....	54	....	....	79	....	....
Slash	......	....	....	1,748	....	....	1,748	....	....
Old burn, not restocking	350	....	....	334	....	....	684	....	....
Total	405	13	....	2,233	365	....	2,638	378	....

On the basis of $1.50 per M. for merchantable timber, $2 per acre for young growth, and $1 per cord for wood, the value of the forests destroyed would be as follows :

*See p. 125, Chap. V.

	Merchantable timber	Young growth	Total
1914	$60,700	$69,836	$130,536
1915	3,793	4,676	8,469
1916	567	158	725
Total	$65,060	$74,670	$139,730

SUMMARY OF THE CAUSES OF FOREST FIRES IN THE RAILWAY BELT

	1914				1915				1916				Average, per cent
	Large	Small	Total	Per cent	Large	Small	Total	Per cent	Large	Small	Total	Per cent	
Railways	1	25	26	5	..	30	30	7	3	28	31	12	6·8
Sawmills and logging	5	12	17	3	3	30	33	8	..	26	26	9	6·0
Brush burning (not settlers' clearing)	..	..	..	..	..	6	6	1·5	..	2	2	1	·6
Settlers	36	72	108	19	11	51	62	14	1	26	27	9	15·4
Campers and travellers	16	112	128	22	2	122	124	28	2	62	64	23	24·6
Incendiary	14	..	14	2	..	3	3	·5	..	2	2	1	1·5
Lightning	29	53	82	14	1	48	49	11	1	48	49	18	14·0
Other known causes	3	25	28	5	2	7	9	2	1	3	4	2	3·2
Unknown	55	114	169	30	23	99	122	28	10	57	67	25	27·9
Total	159	413	572	..	42	396	438	....	18	254	272	..	....

Though the percentage of fires from unknown causes is decreasing, owing to the increased vigilance of the forest rangers, about one-quarter is still classified in this way. Campers and travellers are responsible for almost another quarter of the fires. Undoubtedly a great many of the fires of 'unknown' origin are also due to the carelessness of campers and travellers. Settlers and their clearing operations are next, and it is evident, therefore, that, in the education of the public in regard to the danger of carelessness with fire in the forests, much remains to be accomplished. The provincial permit system applies to the Railway Belt, the permits being issued by the Dominion rangers. Lightning has been the cause of 14 per cent of the fires in the last few years. Though lightning seldom occurs on the coast, it is of frequent occurrence on the mountains in the interior. Fires started by lightning are usually difficult to handle, as they most frequently occur in situations which are relatively inaccessible for a fire-fighting force with its equipment. Railways and lumbering have been responsible for 7 per cent and 6 per cent, respectively, of the fires during the last three years.

The fires due to the former have very markedly decreased, due to the efficient patrol maintained through the co-operation of the Canadian Pacific railway, the Board of Railway Commissioners and the Forestry Branch.

Logging-slash Burning

It is of interest to note that not one per cent of the fires are due to slash burning other than in settlers' clearings, though many of the lumbermen consistently burn their slash every year. Each year, the rangers burn considerable slash in the early spring or

late autumn, to reduce the fire hazard. The appropriations for this work are, however, inadequate, especially in the lower Fraser valley, where slash, due to lumbering, clearing or road building, has been accumulating for years. No more effective measure can be taken for the protection of the forests or of the lives and property of the settlers than by removing this debris, especially along roadsides or adjacent to settlements or industrial operations.

Parks Branch

Forest administration in the Dominion parks in British Columbia is confined almost entirely to fire protection. A few permits to cut dry wood are issued from time to time, but extensive exploitation of the forests is contrary to the policy of the branch. The total cut and revenue for the years 1914 to 1916, are as follows :

	No. permits	Area	Cut		Total revenue
		Acres	Cords	M.b.f.	
1914.........	31	10,026	452·5	32	$204.50
1915.........	34	576	261·5	..	34.50
1916.........	15	555	*	*	36.50

The Parks Branch has developed a very efficient fire protection system, despite the fact that the thousands of tourists who travel through the parks are a constant source of danger. As warnings against starting fires are issued on attractive posters, buttons, match boxes and maps, the co-operation of the public is, in a large measure, secured.

In 1916, there were in operation throughout the three parks, 48.3 miles of road, 254.1 miles of trail and 20.8 miles of telephone line, in addition to the telegraph and telephone lines maintained by the Canadian Pacific railway. A number of ranger cabins and shelters have been built throughout the parks. The field protection staff, in 1916, consisted of two permanent wardens and seven temporary wardens. The duties of these men include both game and fire protection, consequently it is difficult to apportion the expenditure for each part of the service. It would seem fair, however, to charge half of the patrol and improvement expenditure to each.

The total expenditure for fire and game protection has been as follows :

	Patrol	Permanent improvements	Fire fighting
1914................	$2,586.00	$ 678.06	$9,270.44
1915................	4,287.27	971.37	66.00
1916................	4,185.90	1,406.49	No return

*No return of cut for 1916.

CHAPTER VII

Forest Policy

IN this chapter, attention is drawn to a few points in the forest policy of British Columbia which have not been sufficiently covered in the preceding chapters. These are forest revenues, the need of scientific forest research and of a college of forestry.

Forest Revenue

The problem of devising an equitable system for collecting public revenue from forests and forest land has commanded the attention of economists and foresters in Canada and the United States, more especially during the last ten years. Increase in stumpage values apparently justifies the demand for increased revenue, from both private and government-owned forest land. On the other hand, the threatened depletion of the forests necessitates the avoidance of any condition which artificially stimulates the exploitation of the forests or which discourages the production of succeeding crops.

Virgin Forests Not Due To Man

The existence of the virgin stands on forest lands is not due to the enterprise of man, and, therefore, should, primarily, be considered public property, though their utilization is dependent on private efforts ; consequently, the public should share in any increase in value not attributable to private enterprise. Secondly, forests, like other crops, produce a revenue only when used, and, under the conditions of ownership and exploitation prevailing on this continent, the greater portion of the forest land cannot be expected to produce an annual revenue. Thirdly, forest crops take a long time to mature, and high annual taxation on land carrying growing forests imposes a burden which has almost entirely precluded the practice of forestry on private lands. Fourthly, the lands on which the forests grow are, for the most part, unsuitable for any other form of production and should not be subject to the same conditions as, for instance, agricultural land.

Leasing System

Canada has, in the main, recognized these basic principles, and, instead of selling timber-land outright to private interests, the various governments have adopted the leasing system in the disposal of their forest resources.* By this system, the public, while securing an annual revenue from rentals, retains an interest in the stumpage in the form of a royalty on the cut, and the right to control, at least in some degree, the method of exploitation. The private rights, also, are nearly always relinquished when the mature timber is removed and then the Government can use the land for the purpose for which it is best adapted.

*For full discussion of the forms of timber alienation see Chap. IV.

Effect of High Carrying Charges

Next to fire, onerous taxation is the greatest menace to forest conservation. Conservation does not imply the withdrawal from use, but, on the contrary, it implies the fullest utilization, which, in the case of the forests, pre-supposes reproduction. High annual taxation or rentals, or large initial payment for stumpage, which mean correspondingly high interest charges, can, if they prevail generally, result only in over-production. Over-production, in turn, causes low prices, wasteful methods of exploitation and the general demoralization of the industry.

The lumber industry differs from almost all other manufacturing industries in that it is necessary, in most cases, to carry a stock of raw material sufficient to last at least from ten to twenty years. Wood-working industries seldom carry more than a few months' stock, depending upon the lumbermen for supplies.

Of the iron and steel industries in the United States, 55 per cent carry only a few months' stock of ore; the other 45 per cent carry considerable supplies of raw material in the form of unmined ore, which represents only 5 per cent of the value of pig iron. The stumpage value of timber, on the other hand, represents from 10 to 40 per cent of the value of lumber. The risk to which standing timber is exposed from fire, wind, decay and destructive insects must be considered. This item will, on the average, in British Columbia amount to 1 per cent or more per annum.

Revenue Collected on Cut

Since forests are valuable only as they can be used, the logical time for governments to collect their share in the stumpage values is when the timber is cut. By this method the operator pays only for what he can use, and, in fairness to the public, he should be required to cut as closely as the conditions permit. It is only just that the private interests which have been given the right to exploit this public property should contribute a reasonable amount annually to the public revenue. Annual charges, if too low, would encourage speculation and cause monopoly of the raw material which is essential to the prosperity of the lumber industry and to the consumers of forest products.

Forests Alienated Beyond Requirements

As a matter of fact, the forests of British Columbia have been alienated far beyond the requirements of the lumber industry. The license system, though it has yielded a phenomenal revenue to the Government in the form of rentals, has undoubtedly encouraged timber speculation. The timber sale method, which limits the tenure to such a short period that continuous operation is required, is, of course, the most effective method of preventing speculation. We have, however, to deal with conditions as they are and not as they should be. With 260 billion feet of timber in private hands, and a present annual cut of less than 1½ billion feet, high annual carrying charges can only result in either over-cutting or confiscation.

Cash Bonuses

The objections to high annual taxation or rentals apply equally to cash bonuses, such as are required by the Dominion Government. The accruing interest charges have the same effect.

The following table shows the effect which a bonus of 50 cents per M. would have had on the accumulated charges, if applied in 1907 to an average provincial license on the Coast. The stand is taken as 10,000 b.f., the rental at $140 per license, and interest at 6 per cent.

Year	Bonus and interest	Rental	Total
1915	$0.80 per M.	$0.14 per M.	$0.94 per M.
1920	1.07 " "	0.26 " "	1.33 " "
1925	1.43 " "	0.43 " "	1.86 " "
1930	1.91 " "	0.66 " "	2.57 " "
1935	2.56 " "	0.96 " "	3.52 " "
1940	3.42 " "	1.36 " "	4.78 " "
1945	4.58 " "	1.90 " "	6.48 " "
1950	6.13 " "	2.63 " "	8.76 " "

Though the trend of stumpage values is toward higher levels, a study of these carrying charges will convince the timber owner that he must, even at the sacrifice of efficiency, realize on his investment as quickly as possible. If he had only the rental to pay he might conserve his timber until market conditions warranted his cutting it. The forcing on the market of 100 billion feet of lumber in ten years, when there is normally a market for only about 1½ billion feet per annum, would have a demoralizing effect.

Forest Taxation in Washington and Oregon

In the neighbouring states of Washington and Oregon, where the timber-land is held in fee simple, the taxation is dependent on local revenue requirements, and no uniform rates exist, either from year to year or for the various counties. Efforts are being made to have state control of timber-land taxation, the state returning to each county its proportion of the taxes. In Oregon, the average taxation on timber-lands at present amounts to about 50 cents per acre, and in western Washington to about 85 cents per acre. The following comparison of the cost of carrying timber at these rates of taxation with those in force on provincial licenses is very favourable to the British Columbia system.

CUMULATIVE COST PER ACRE OF CARRYING TIMBER AT DIFFERENT RATES OF RENTAL OR TAXATION

(Interest at 6 per cent per annum)

Length of time years	B.C., 'Interior,' at $100 per sq. mile	B.C., 'Coast,' at $140 per sq. mile	Approximate average in Oregon, at 50 cents per acre	Approximate average in western Washington at 85 cents per acre
10	$ 2.06	$ 2.88	$ 6.59	$ 11.20
15	3.62	5.09	11.68	19.78
20	5.75	8.05	18.39	31.27
25	8.57	12.00	27.43	46 63
30	12.35	17.17	39.52	67.20
35	17.41	24.38	55.72	94.72
40	24.18	35.41	77.38	131.55
45	35.74	46.54	106.37	180.83
50	45.36	63.51	145.17	246.79

In some localities in Oregon and Washington, where large expenditures on local improvements are made, much higher assessments prevail, and, what

Plate XX

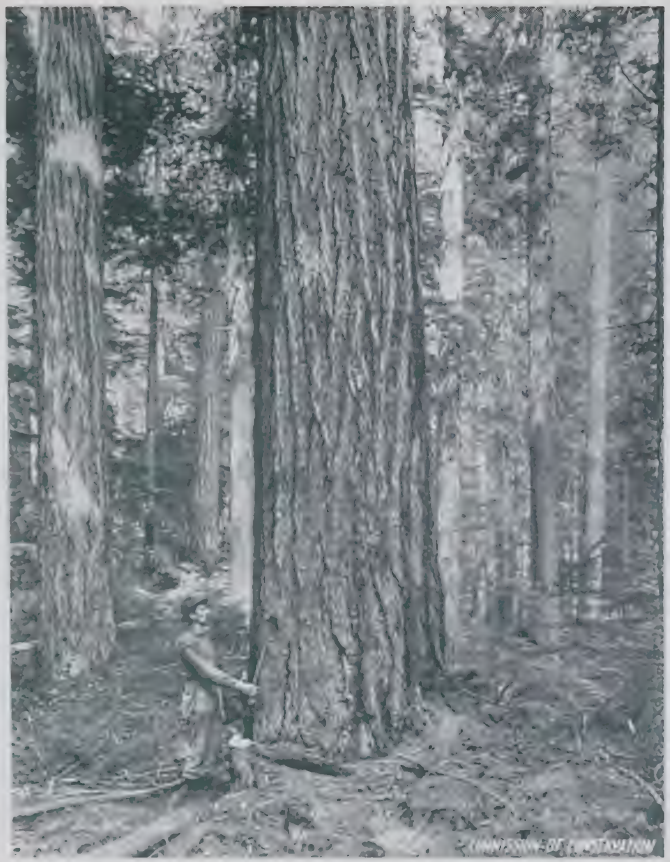


Photo. by Shields Lumber Co.
DOUGLAS FIR, FRASER VALLEY

Photo. by Shields Lumber Co.
RED CEDAR, FRASER VALLEY

alarms the lumbermen is, that the rates are constantly increasing and they do not know when the increases will cease.

The following is a typical example of this increase in the taxation on a 30,000-acre tract in Washington :

1905	17.2 cents per acre	1910	46.4 cents per acre
1906	21.3 " " "	1911	56.8 " " "
1907	28.4 " " "	1912	70.1 " " "
1908	38.3 " " "	1913	83.3 " " "
1909	39.1 " " "		

Maximum Rentals Fixed in B.C.

In British Columbia the maximum rental that can be charged on licenses is fixed until the end of 1954, thus assuring the lumber industry, in advance, a guarantee that the cost of carrying the timber will not exceed a specified amount.* The fee of $140 per square mile in the Coast region and $100 in the Interior, or mountain section, is as high as the industry can stand and, by fixing these rates as maximums only, the Government may make a reduction should such be found advisable to obviate a loss of revenue through the surrender of less accessible limits. The *Report of the British Columbia Forest Branch*, 1916, shows that, out of a total of 15,065 licenses in force in 1908, 1,108 have expired and 5,828 are in arrears for fees for from one to four years. The latter may be reinstated under the Forest Act Relief Act, but it is estimated that at least one-half of the number will be relinquished by the holders.

Scientific Forest Research

In the development of a forest administration, such as that in British Columbia, the first efforts, as is natural, are directed towards protection against fire and towards the collection of revenue. The solving of the, so-called, 'practical' problems is demanded by the public. Abundant supplies of raw material, easy exploitation and simple market demands do not tend to stimulate a closer study of the forests. The time has come, however, when it is necessary to secure a technical knowledge of the forests, in order that they may be perpetuated, and of the products of the forests, in order that they may be marketed and utilized to the best advantage. The aim of the administration, in the past, has been limited to converting as much as possible of the accumulated wealth of centuries into cash without delay. Forestry should go farther, and make the forest a perpetual source of wealth.

Silviculture, like agriculture, should be based on a scientific knowledge of the needs and quantities of the crops which are to be produced. Before silviculture can be intelligently practised, definite knowledge is necessary in regard to each species, as to the time of seeding, method of seed distribution, requirements as to soil, light, moisture and temperature, rate of growth, form and the ultimate utility.

In every country where forestry is practised the need for scientific research has been recognized. Forest conditions vary so greatly throughout the world that local investigations are necessary. Scientific research can only be suc-

* See page 92, Chap. IV.

cessfully conducted by specialists, who can devote their entire time to it. Investigation conducted incidentally by a man whose chief functions are administrative is seldom of very great value.

In Sweden, Russia, Germany, Austria, Switzerland, France, India and the United States forest research is one of the most important branches of the forest administration. In the United States, where the forest problems more closely resemble ours, the growing demand for scientific facts, upon which to base the forest administration, has led to the establishment of permanent experiment stations in each of twelve districts in the west recognized as silvicultural regions. In addition, a central laboratory for the study of forest products is maintained at Madison, Wisconsin.

Forest Products

In Canada, the only research work in forest products is conducted by the Dominion Forestry Branch, in its Forest Products Laboratories in Montreal. Though this plant was only established in 1914, much valuable work has been done in connection with the testing of the mechanical properties of woods* and in connection with the manufacture of pulp and paper. These laboratories are admirably situated for investigation of the forest products problems of eastern Canada, especially those of the important pulp and paper industry, but the distance from British Columbia renders it difficult for the staff to keep in touch with the laboratories or to solve the many local problems which affect the trade in lumber or other wood products in that province. Up to 1916, of silvicultural investigations, in the forest, only the smallest beginnings had been made, and these chiefly by the Dominion Forestry Branch, the Quebec Forest Service, and the Commission of Conservation. It is, however, gratifying to note that plans for the future contemplate the material expansion of this line of work, as rapidly as conditions render such action feasible.†

For a number of years wood has been losing ground as a construction material, its place being taken by such substitutes as steel, cement, brick, terra-cotta and patent-roofing materials. Though, in some cases, the use of these substitutes is justified, in the majority the replacement of wood by other materials has been due to a lack of knowledge concerning wood and its uses, coupled with a lack of progressive salesmanship on the part of lumbermen. It is of the utmost importance that reliable and exact data concerning the strength, durability and weight of each kind of wood should be available for builders, especially for engineers and architects, who have to choose between the use, not only of wood or some other material, but the kind and grade of wood best adapted to their needs. The strength of wood of the same species varies with its structure, and the structure varies to a large extent with the climatic conditions under which it is grown. It is important, therefore, that information on the local woods should be secured. The United States can supply very complete information about Douglas fir, which is known to the export trade as 'Oregon pine,' but, unless conclusive proof is offered, it is difficult to convince the foreign buyers that our Douglas fir is just as

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* *Canadian Woods for Structural Timbers.* Dominion Forestry Branch, Bulletin 59.

† See footnote, p. 163.

strong, or, perhaps, stronger, than that grown in the United States. Grading rules should be scientifically based on such structural features as width of the annual rings and proportion of summer-wood, as well as on such superficial features as the presence of knots, the proportion of heartwood, straightness of grain, etc.

Specifications based on actual tests are required of wood for use for special purposes. Frequently, grades of wood are used for purposes for which they are not sufficiently strong or durable ; as a result, substitute products secure additional converts. More frequently, however, the specifications call for valuable species and valuable grades being used where cheaper material would answer the purpose just as well.

The pulp and paper industry presents an immense field for investigation, concerning the processes used for the conversion of wood to paper. The possibility of utilizing saw-mill waste, or such species as lodgepole pine and Douglas fir, for this purpose is worthy of extensive investigation.

Preservative Treatment of Wood

The preservative treatment of wood, to prevent destruction by decay, insects, marine borers, mechanical abrasion or fire, is an industry which is, each year, becoming of greater importance. It has been developed to a point where its feasibility and utility have been demonstrated, but much remains to be done in the way of improving the processes of impregnation, reducing the cost and devising methods of treatment for certain kinds of wood and for special purposes. Three of the most important local uses for treated timber are railway ties, piling, and wood blocks for paving. The successful treatment of woods for these purposes will greatly extend the use of wood. In this connection it may be pointed out that the average estimated increased life, in years, of wood by preservative treatment is as follows : *

	Untreated	Treated
Ties	7 years	17 years
Poles	13 "	26 "
Posts	8 "	24 "
Piling	3 "	20 "
Mine-props	3 "	15 "
Shingles	20 "	35 "
Lumber	8 "	20 "

There is, in India, a most profitable market for Douglas fir railway ties so treated that they will withstand the attacks of white ants. The Indian Government is anxious to co-operate in such necessary investigations as will enable it to procure its supplies in Canada.

Seasoning of Wood

The lumber industry also needs more information on the seasoning of wood. As the climate on the coast is unsuited to air-drying, practically all lumber and shingles are dried in kilns. The time during which the lumber is held in the kilns increases the expense of manufacturing and the tendency is, therefore, to hasten the process

* *Preservation of Structural Timber*, Howard F. Weiss, p. 3.

as much as possible. Rail freight rates are based on actual weight, which offers an inducement for over-drying, especially of shingles. Much good material is ruined in the kiln-drying, and it is claimed that, except for the saving in freight, drying of shingles has no justification, and that green shingles lay better, last better and are in every way more satisfactory. Authoritative information on these and many other subjects should be available for the trade, and the establishment of a forest products laboratory in the province would be of very great value in the development of the lumber industry, upon which the welfare of the province so largely depends.

Volume Tables

Administration of a forest property requires that accurate information be obtained as to the quantity, quality and value of the standing timber. When stumpage values were nominal, timber was bought and sold on the acreage basis, but, as these values increased, knowledge of the amount and kind of timber became more essential as a primary basis for all transactions. Early methods of estimating standing timber were based, almost altogether, on the experience of the estimator in logging comparable stands. The standard for merchantable timber used in making these cruises was usually conservative enough to protect the purchaser. The lack of any definite standard on which to base an estimate of the amount of wood in a single tree or stand results in extreme variation in reports by different cruisers. One example is cited where a limit on the coast was cruised ten years ago at 6,500,000 b.f. The owner logged off 5,000,000 b.f., and a later cruise showed over 15,000,000 b.f. remaining.

One of the first things which a forester needs in his work is a series of volume tables, on which to base his estimates of the standing timber. Volume tables give the timber contents of trees for various diameters and heights. They can be compiled only from the actual measurement of a large number of trees in order to obtain reliable averages. Distinct tables are necessary not only for each species, but for the same species in different localities, since the form of the trees varies to a considerable extent with climatic and site conditions. Private forest engineers have, at considerable expense, compiled their own volume tables, while both the Dominion and Provincial forest services have commenced collecting the necessary data. Much, however, remains to be done before a complete set can be given to the public. Standardization of timber cruising is just as important as the standardization of log scaling. As far as they go, the volume tables for Douglas fir, western red cedar and western hemlock, published by the Forest Branch in 1914, are very useful, but they can be used with safety only in the southern coast region. These tables will be found in Appendix No. 2.

Reproduction Investigations

With the exception of one season's work, conducted in the southern coastal forests by Dr. C. D. Howe, for the Commission of Conservation,* no concrete information has been secured concerning the extent or nature of the young growth which is, or should be, replacing the original stands removed by logging or destroyed by fire. In

* *Forest Protection in Canada, 1913-1914*, p. 212-230.

this investigation, sample areas, representing different conditions as to site, composition or stand and age, were selected and carefully studied, and the results obtained are of great practical value by establishing the following facts :

1. On about one-half of the area logged and burned in the past 20 years, the forest reproduction is not sufficiently abundant to insure the re-establishment of the commercial forest. The other half, however, is well stocked with young trees, and, if not burned, a forest yielding saw-logs is assured.

2. It is evident that light burning of the slash and dense undergrowth gives the best reproduction of Douglas fir.

3. Better protection of the reproduction of fir already established is imperative, since second and subsequent fires have already destroyed about one-half of the reproduction originally established.

The continuation of this work in other forest regions, and in connection with other species of trees, is necessary, in order that methods of exploitation and protection may be adopted which will encourage reproduction, and that the public may be informed as to the value of the young growth and the necessity for its protection.

The rate of growth of the various species of trees in British Columbia is a subject concerning which no information is available. Definite knowledge in this connection is fundamental in the development of a forest policy which aims to secure the highest sustained production possible. There is no doubt that, from the standpoint of maximum financial returns, the large trees in the virgin stands are long past maturity. It may be that, under certain conditions, it is more profitable to cut as soon as the timber is fit for pulpwood, posts or piling, than to wait for the trees to grow to saw-material sizes. A knowledge of the rate of growth is essential in the valuation of growing timber for purposes of taxation and for the assessment of damages from fire or other causes.

To conduct investigations along these lines, permanent experiment stations should be established in the forests, where all the conditions affecting the forest, from the seed to the mature stand, can be observed and controlled for a sufficient time to secure definite and reliable conclusions.

Grazing Problems

In the central portion of the province are large areas of the public domain which are suitable for the grazing of live stock. Nearly all of this land is unsuitable for the production of field crops, on account of the altitude, topography or soil conditions. A small percentage of it is treeless, but most of it is partially timbered. In some parts dense growths of small timber are found, composed chiefly of lodgepole pine and poplar, of very little commercial value. There is evidence that much of the open land is being over-grazed, with serious results.

The importance of the live stock industry justifies a thorough investigation of grazing problems. It is believed that, in many locations, the land could be used to better advantage for stock raising than for growing timber. In

other localities, forests are more valuable, either for the timber they produce or for the protection they afford the water supply. In many places, forestry and grazing can be conducted simultaneously, under proper regulation. It may be found advisable, in order to maintain or improve the grazing, to seed or otherwise re-establish the grass on some of the ranges.

The success which has attended the administration of the grazing in the national forests of the United States has demonstrated the benefit which intelligent regulation confers upon the live stock industry, notwithstanding the bitter opposition which the introduction of the reforms, at first, encountered. Fortunately, such opposition has now disappeared, so far as the national forests are concerned.

Forest Entomology and Forest Pathology

The damage being done to the forests by insects and fungi demands thorough investigation and constant attention, in order that the most practical measures of control may be discovered and applied before the outbreaks reach dangerous proportions. The Entomological Branch of the Dominion Department of Agriculture has conducted valuable investigations on forest insect pests* in British Columbia during the last few years, but the Federal Government cannot be expected to carry on the extensive and constant campaign against these pests which the situation demands. As far as known, no attention has been paid to the fungus diseases which are destroying millions of feet of timber in this province.

A College of Forestry Required

There is urgent need for a forestry college in British Columbia. The nearest college in Canada is in Toronto. The distance from British Columbia precludes the attendance of all short-course students, and of many others who might be able to take a complete course in a local institution. The forest conditions on the coast differ to such an extent from those of eastern Canada that considerable experience under western conditions is necessary before eastern-trained men are able to render effective service in British Columbia. The work of such a college would be divided between educating men for forest work, and conducting scientific research along forestry lines. The need for the latter has been pointed out. The preparation of technically trained men for the administrative work of the Provincial and Dominion services is only one of the objects. The practical application of forestry depends largely on the rangers in the field. At present the only opportunity these men have of acquiring the viewpoint of the forester is by correspondence or from the occasional visits of inspectors. By furnishing these men with short courses in the winter, they would be benefited, not only by the technical training in cruising, mapping, scaling and methods of protection, but they would develop an intelligent interest in their work. This, in turn, would tend to develop an *esprit de corps* in the service, which would greatly increase its effectiveness.

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* See Chapter on Forest Insects.

The training these men might thus secure would enable them to advance in the service, which, under the present conditions, is almost impossible. Permanency of the staff and freedom from the exigencies of politics are essential in forestry, and the attainment of these conditions would be greatly facilitated if a certain amount of technical training could be insisted upon.

Exploitation of the timber in British Columbia calls for a high degree of engineering ability, and, as the operations become larger and the more accessible timber is removed, the demand for specially trained logging engineers must increase. The training for this work would include not only a knowledge of surveying, mapping, road and railway building, machinery, etc., but an intimate knowledge of the forest, including cruising, and the problems connected with the manufacture of forest products. The opportunities in private work for forest engineers will be increasingly promising.

When the University of British Columbia was established it was suggested that forestry be one of the subjects to be taken up, but, up to the present, nothing has been accomplished. As the University is already equipped to furnish the necessary preliminary instruction in mathematics, chemistry, botany, physics, engineering, etc., all that is necessary to establish a faculty of forestry is a small staff of technical instructors and some equipment.*

The establishment of a forest products laboratory in connection with the University, on a basis similar to that at McGill University, would be mutually advantageous.†

The establishment of a college of forestry is being very strongly urged by the lumber industry. The British Columbia Lumber and Shingle Manufacturers' Association, the British Columbia Loggers' Association, the British Columbia Forest Club and other organizations have made several appeals to the Government in this connection, and it is to be hoped that favourable action will be taken.

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*The beginning of forestry instruction in British Columbia is seen in the establishment at Vancouver, commencing March 25, 1918, of a four weeks' course in forestry for returned veterans who desire to qualify as forest guards. This course was opened under the auspices of the Vocational Branch of the Military Hospitals Commission, the classes being intended to serve students from the four western provinces. This activity involves co-operation with the Military Hospitals Commission, on the part of the University of British Columbia, British Columbia Forest Branch, Dominion Forestry Branch, Imperial Ministry of Munitions, Imperial Munitions Board, and a prominent firm of consulting foresters.

† Since the foregoing was in type, announcement has been made (April, 1918) that arrangements have been completed for the establishment at Vancouver of a branch of the Forest Products Laboratories maintained at Montreal by the Dominion Forestry Branch in co-operation with McGill University. For the present, the Vancouver laboratory will limit its activities primarily to timber-testing work, specializing, first, in the solution of problems arising out of the production of airplane material. After the war, it will be possible to greatly expand the scope of investigations which can be handled by this laboratory. It is noted that this development involves co-operation between the Dominion Forestry Branch, British Columbia Forest Branch, Imperial Munitions Board, and University of British Columbia.

CHAPTER VIII

Forest Exploitation

THE lumber industry has played an important part in the development of British Columbia. The fur trade with the Indians first attracted the British to the Pacific coast. Prior to the Oregon treaty, which defined the boundary between the British and United States territories west of the Rockies, the Hudson's Bay Co.'s headquarters were at Fort Vancouver, on the Columbia river, and near the site of the present city of Portland. The acceptance of the 49th parallel as the international boundary led to the removal of headquarters from Fort Vancouver to a point within British territory. A party, under James Douglas, left Fort Vancouver in the *Beaver* and arrived in Camosun bay on March 13, 1843. At this point, which is now the city of Victoria, the new headquarters of the company were established.

The scene which greeted the eyes of these pioneers is a striking contrast to the present beautiful city. "It was indeed primeval in appearance. Before them lay a vast ocean-bound body of land upon which no white man now stood. Not a human habitation was in sight, not a beast, scarcely a bird. Even the distant murmur of the voiceless wood was drowned by the gentle beating of the surf upon the shore."*

Subsequently other posts were opened at several points on the island, including Nanaimo and Fort Rupert. Since the company was more interested in the fur trade than in colonization, the settlement grew very slowly. The discovery of gold along the Fraser river, in 1857, brought a great influx of population, chiefly from the California gold-fields. In May, June and July, 1858, at least 23,000 persons left San Francisco by boat and about 8,000 by land bound for the new gold-fields. This gold 'rush' brought the mainland into prominence.

Early History of Lumber Industry

Of the early history of the lumber industry in British Columbia, very little is recorded. Its development would form an interesting and instructive subject, and the facts should be secured while some of the 'old-timers' are still alive to supply them.

In an address delivered at the Forestry Convention at Vancouver, in 1906, the late R. H. Alexander, then manager of the British Columbia Mills, Timber and Trading Company, and one of the pioneer lumbermen in the province, gave the following short but interesting account of the growth of the industry :

"The first mills in the province were at Esquimalt and Sooke, on Vancouver island, and were only for the requirements of the early settlers. The first mill of any size for the prosecution of the export business was established at Alberni, on the west coast of Vancouver island, about 1861 or 1862, but the

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*Bancroft, *History of British Columbia.*

business did not prove successful, and was in operation only a few years when it was closed, and the machinery sold to some of the mills on Puget sound. There was a small sawmill at New Westminster in 1862, catering to the local trade, and which shipped, I think, one cargo abroad. Parties who had been connected with this enterprise started the first mill on Burrard inlet, a year or two afterwards, at Moodyville, which was followed by the building of the Hastings mill on its present site in 1865 ; and, with the erection of these mills, the foreign lumber trade of British Columbia may be said to have commenced. For a number of years the foreign trade of the province averaged from 25 to 35 million feet annually, until the Chemainus mill came into operation ; since then the trade has varied from 50 to 80 million feet per annum. This year, the Fraser River mill has joined the export shippers, and the foreign shipments will probably reach 85 million feet, the largest volume since the inception of the business.

Canadian Pacific Railway

"Until the construction of the Canadian Pacific railway, there was no market available but the foreign, and large quantities of lumber that, under other conditions, would have found a sale, used to be burned as the only way for its disposal.

"The advent of the Canadian Pacific railway opened a market to the east, and mills began to multiply. It was a long time before our Douglas fir established itself, but it crept farther and farther east, until now we have customers even on the seaboard of the Atlantic provinces, and the quantity being shipped in that direction is ever increasing. Our export trade is distributed all over the world, shipments being made to Australasia, China, Japan, and, occasionally, to India, Central America, Peru, Chile and the Argentine Republic, the United Kingdom, France and Germany ; it has even penetrated to Baltic ports, which might appear like sending coal to Newcastle, and is being used in the modern development of that ancient country Egypt, and aiding in the building of Johannesburg and in the mining of gold in the Rand mines of the Transvaal.

"In several of these markets, however, our wood is not in general use, but is only taken in the form of special sizes and lengths that cannot be obtained elsewhere, our great distance from the points of consumption and costly transportation militating against it being used in a more general way. Until recently the transportation of lumber has almost entirely been left to sailing vessels, but steam is now competing for the business, and when, by this means, the distant markets can be reached more quickly, we may confidently expect our trade with them to increase. With the expansion of the export trade it is interesting to note the increase there has been in the size of the vessels used. In the early days of the trade a vessel carrying over 400,000 feet was a large one, and to supply a cargo of 1,000,000 feet was an undertaking so colossal as to make a mill manager stand aghast, while now it is a difficult matter to obtain a vessel to carry such a small cargo, and steamers carrying 3,000,000 feet are not uncommon visitors.

"Coincident with the increase in the size of the vessels has naturally been the increase in capacity and improvement in the machinery of the mills, from the mill of early days producing 50,000 feet, in which a great deal of manual labour was employed, to those of a capacity of 200,000 per day, equipped with the latest machinery and labour-saving devices, whilst the working day has been reduced from eleven and a half to ten hours.

"In 1885, when the Canadian Pacific railway reached Vancouver, the output of the Coast mills of British Columbia did not exceed 75,000,000 feet, and this year (1906), including shingles, it will reach 525,000,000 feet.

Forest Revenue

"In that year (1886) the revenue arising from the forest was only $3,768, while last year (1905) it amounted to $578,748. In making this comparison, however, a large share has to be credited to the growth of the lumbering business in the interior of the province. The development of the shingle industry has also greatly assisted this result, as, at the commencement of the same period of twenty years ago, there were only a few machines in use supplying the local requirements and finding it difficult to supplant the old hand-shaved shingles ; there are now 155 machines in operation, capable of turning out 1,000,000 M. shingles per annum, and the excellence of our manufacture has not only obtained for British Columbia shingles the trade throughout Canada, but has gained for them a preference in the United States.

"The increase in the manufacturing of lumber of necessity required an increased production of the raw material from the forests and an improvement in the methods of logging.

Timber Leases

"In the 'seventies,' I think the only mills having leases of timber-land were the Hastings mill and the Moodyville mill, for which they paid the Provincial Government one cent per acre without any further dues, and the revenues could not have amounted to more than $600, from which it has increased, as before mentioned, to nearly $600,000. Whilst these mills operated their own camps on their own leases, others cut timber wherever they felt inclined, no one then placing any value on the standing timber.

Logging Methods

"Oxen were the motive power used for the transport of the logs to the water, and the most important man in the camp and the one getting the highest wages was the 'bull-puncher,' or teamster, who gained the above name from driving with a goad stick in the end of which was inserted a brad which was liberally used, along with a good deal of strong language, to make the cattle exert themselves. When moving from camp to camp a teamster generally carried his goad stick as a sort of insignia of office, and it may be a surprise to hear that $5 was an ordinary price for a good hickory goad stick. The teamsters' wages ran as high as $125 per month without any deduction for lost time, and it was a sight to see their skilful manœuvring of a team of twelve and sometimes fourteen bulls in the dense woods. At this time there were also a number of what were called hand-loggers, who, finding a locality where timber grew on a slope close to the beach, with the aid of jackscrews, wedges, an axe and crosscut saw, put in the water no inconsiderable portion of the log supply. Later, the camps substituted horses and mules as being faster than oxen, but all these methods have been practically superseded by the use of steam haulers, with fully equipped railways, for the main roads where the operations are of sufficient magnitude.

Douglas Fir Used Exclusively

"Until comparatively recent years, the only lumber manufactured by the mills was the Douglas fir, which, I regret to say, is known abroad more generally under the commercial name of 'Oregon pine.' How it received that name it is difficult to account for, as the first shipments were sent abroad from Puget sound, then Washington territory, but the name has remained, and it is most difficult to change a name which, by use, has become a familiar commercial term. Our British Columbia product, I am pleased to say, has, in many instances, a preference as having a closer grain, and in Europe, at least, is frequently referred to as Columbian pine, in contra-distinction to the other. Our other woods of commercial use are cedar, spruce and hemlock. Our cedar furnishes the material for our large shingle trade, and is in request also for finishing lumber and the manufacture of doors and sashes. Spruce is not so plentiful, but the upper grades find a ready sale in various forms, while the lower furnish the material for box-making.

SITKA SPRUCE, NADEN HARBOUR, GRAHAM ISLAND

Photo. by Shields Lumber Co.
WESTERN WHITE PINE, FRASER VALLEY

The last wood I have mentioned is hemlock, and, hitherto, hardly any use has been made of it except for piles, and for no other reason that I know of than its name. The hemlock of the Pacific coast is a very different tree from that in the east, being much longer in fibre ; it is somewhat harder than spruce, though less than fir. Experiments with it have proved it a first-class wood for interior finish, and I really believe that its use will quickly increase when prejudice is overcome, and will be esteemed as highly as our fir is at present. From a forestry point of view, I am sure it will prove of the highest value, as it rapidly reproduces itself and flourishes in heavy shade. A walk through our park will furnish our visitors interested in forestry with examples without number of this tree having reproduced itself amongst dense underbrush, on fallen and partially decayed trees, and even on the tops of stumps of fir trees which have been felled, and it has been described by one of the timber experts connected with the University of Washington as an ideal tree for reforestation on account of its ability to exist under the conditions just mentioned.

Expensive Logging

"Logging operations on the coast of British Columbia will always be expensive and will rapidly increase in cost from the general characteristics of this country. This generally rises sharply from the seashore without any large area of fairly level land; this necessitates constructing roads from the shore at several different points to obtain the timber from one moderately sized limit, and it becomes a question whether there is enough timber tributary to any one road to justify its construction. As the timber within easy reach of the shore becomes exhausted, this condition will be intensified in proportion to the length of the roads necessary and only large compact areas of timber will justify the expense of building railways many miles inland. The cost of working small areas will rapidly increase, and I am therefore of opinion that the price of the raw material will have to increase accordingly. If my view is correct it follows as a certainty that the price of the manufactured article must increase also, and this, I think, will be the case generally on the Pacific coast. The rapid exhaustion of many former sources of supply of constructional timber leaves practically but two large areas available for future supplies. These are the yellow pine region of the south and the Pacific northwest."

The early logging was done by oxen; later, horses were used but now donkey engines, operated by steam, are almost exclusively used. Electricity has been used where the power was available; but, though it has some advantages over steam, it is not likely to be used to any great extent for some time yet. In the interior of the province, where the timber is smaller, horses are still used to some extent; but, even there, the use of logging machinery is becoming more general.

It is claimed in British Columbia that the adaptation of steam engines to logging originated in that province about 1875. Two old traction engines had been brought out from Great Britain for use in freighting on the Cariboo road; but, on account of the sandy nature of the roads, it was found impracticable to use them for that purpose. The Hastings Mill Company were then logging at Kitsilano, now included in the city of Vancouver. They bought these engines and, for several years used them to haul logs to the water at English bay.

Logging by Donkey Engine

This successful use of steam power led to the development of the fixed donkey engine, which hauls the logs in by means of a cable. The first engine of this type also was used on English bay. It was a home-made affair, the boiler being taken from an old steamer. From this humble beginning the present high-power engines and complicated

logging machinery have developed. In the ordinary logging camp two types of engines are used. Light engines, known as 'yarders,' are used to haul the logs from where they fall to the main skid road. These engines ordinarily operate within a radius of one-quarter mile. Heavier engines, or 'roaders,' then haul several logs, fastened end to end by dogs, down to the water or railway on skid roads made of logs. The earlier method, evidently a survival of the bull-team system, was to build the road of cross skids, placed 6 to 8 feet apart, and firmly braced, a groove being cut on the upper side for the log to ride in. This type of road has been largely replaced by the fore-and-after type, which consists of a trough made of logs laid end to end. A 'roader' can, under ordinary conditions, haul the logs for a little over a mile.

Destruction of Young Growth

Dragging huge fir, cedar and spruce logs through the woods is not accomplished without considerable destruction of the young growth. Trees two or three feet in diameter are sometimes pulled over. Obstacles, in the form of rocks and stumps, encountered in hauling logs along the ground cause not only serious delays, but also heavy wear and tear on the equipment. To obviate this, the 'high-lead' and the 'overhead-cable' systems, which lift the log off the ground, have been developed.

High-lead and Overhead Systems

With the high-lead system, a pulley, or 'block', through which the main cable runs, is attached to a spar tree near the engine at a convenient height, usually 75 to 100 feet, from the ground. The block at the outer end of the line is fastened to a tree or stump near the ground. When the log is being hauled in, the front end, to which the 'choker' is attached, is lifted off the ground and the obstructions are largely avoided.

By the overhead-cable system the logs are handled by means of a carriage which travels on a taut wire, both ends of which are elevated. By this method the logs are lifted clear of the ground and inequalities, such as valleys, rocks or stumps, are avoided. In 1916, four of the large operators on the coast and one or two in the interior were using overhead-cable systems.

Chutes are used to a considerable extent where the grade is sufficient for the logs to run freely. Flumes are beginning to be recognized as one of the cheapest means of log transportation where there is sufficient quantity of timber to be taken out to justify the initial expenditure.

Logging Railways

Up to about ten years ago, logging on the coast was confined to the timber close to the shore. Three miles was about the limit to which donkey engines could be successfully used. Since that time a number of logging railways have been built to reach the timber farther inshore. The use of railways in place of main skid-roads is increasing, since the former cost very little more to construct, except for the steel, which can be relaid, and are much more efficient. Twenty-one logging railways were in use on the coast in 1916.

River driving is practised in parts of the interior, where the logs are smaller than they are on the coast and where the rivers are not so swift. Very few of the rivers on the coast can be driven, however; they are usually swift and rough, and those large enough to transport the big logs are, as a rule, choked at the outlet with tideland flats and islands, which render driving difficult.

The cost of logging varies according to the location, the nature of the ground and timber, and the cost of labour and supplies. In 1916, very little logging was done on the coast under $4 per M. or over $8, the average being about $6.50 per M. In the interior, as a general rule, the cost would be slightly in excess of these figures.

Towing Logs

Nearly all of the logs taken out on the coast have to be towed to the mills. For this purpose they are made up into booms about 60 to 70 feet wide and 500 to 1,000 feet long. The outside boom-sticks are held together by chains and the boom is kept in shape by long 'swifters,' which are laid across the top of the boom and fastened at each end to the boom sticks. These booms do not stand very rough water, but, on the inside passage between Vancouver island and the mainland, the percentage of loss is small. Where rough water is to be encountered, cylindrical cribs, bound together by cables, are used with success, logs having been towed over 400 miles in safety. Though a few of the mills own their own tugs, the towing is generally done by special towing companies, who charge on a per thousand feet basis, according to a more or less fixed schedule of rates. As in other lines of business, supply and demand and also weather conditions influence the rates, but the following schedule represents the usual charges :

From	To Vancouver		To New Westminster		To Victoria		To Anacortes, Wash.	
	Logs, per M.	Bolts, per cord	Logs, per M.	Bolts, per cord	Logs, per M.	Bolts, per cord	Logs, per M.	Bolts, per cord
Harrison lake	$1.25	$1.35	$1.00	$1.10	$1.25	$1.35	$1.25	....
Pitt lake	.40	.50	.20	.25	.90	1.00	1.00	....
Howe sound	.25	.50	.40	.75	1.00	1.00	1.00	....
Jervis inlet	.75	.90	1.00	1.10	1.00	1.10	1.10	....
Powell river	.60	.90	.85	1.10	.85	1.10	1.00	....
Toba inlet	1.00	1.10	1.85	1.25	1.25	1.25	1.25	....
Bute inlet	1.00	1.10	1.25	1.25	1.25	1.25	1.25	....
Loughborough inlet	1.00	1.20	1.25	1.25	1.25	1.25	1.25	....
Knight inlet	1.50	1.50	1.75	1.75	1.75	1.75	1.75	....
Gilford island	1.50	1.50	1.75	1.75	1.75	1.75	1.75	....
Belize inlet	2.50	2.50	2.75	2.75	2.75	2.75	2.75	....
Hardy bay	1.75	1.75	2.00	2.00	2.00	2.00	2.00	....
Salmon river	1.00	1.20	1.25	1.25	1.25	1.25	1.25	....
Rock bay	1.00	1.10	1.25	1.20	1.25	1.20	1.25	....
Comox	.90	.90	1.15	1.00	1.15	1.00	1.25	....
Nanaimo	.50	.75	.75	.75	.50	.75	.75	....
Chemainus	.50	.75	.75	.75	.50	.60	.65	....
San Juan	1.50	1.50	1.75	1.75	1.00	1.00	1.25	....
*Barkley sound	2.50	....	2.75	....	2.00	....	2.25	....
*Clayoquot sound	2.50	....	2.75	....	2.50	....	2.75	....
*Kyuquot sound	2.50	....	2.75	....	2.50	....	2.75	....
*Quatsino sound	2.50	....	2.75	....	2.75	....	2.75	....
†Rivers inlet	2.00	....	....	....	....	....	....	....
†Bellakula	2.50	....	....	....	....	....	....	....
†Swanson bay	2.50	....	....	....	....	....	....	....
†Kitimat	3.00	....	....	....	....	....	....	....
†Alice arm	4.50	....	....	....	....	....	....	....
†Masset	4.50	....	....	....	....	....	....	....
†Skidegate	3.00	....	....	....	....	....	....	....

*From these points logs can be towed to the milling centres only in cribs, and as yet few attempts have been made to tow logs from the west coast.

†Logs from these northern localities will be sawn locally and seldom towed to southern ports.

Logging Industry

The greater portion of the logging on the coast is done by independent loggers, who sell their output to the mills, either directly or through brokers. The logs are measured by government scalers, and all transactions are based on the government scale. Quite a few mills operate camps, but few of them take out sufficient for their own needs. In the interior, however, the logging is generally done by the mills.

The prices of logs on the coast vary greatly, according to supply and demand. As long as any considerable proportion of the logging is done by small outfits, with limited financial resources, unstable conditions will exist in the log market. These small operators usually have to sell their cut quickly, to meet expenses for labour and supplies, and the millmen take advantage of the situation to depress the price. On the other hand, the millmen do not, as a rule, carry large stocks of logs, and a brisk lumber trade, or diminution in the supply of logs, causes a sharp rise in the price. The logging industry is, however, getting into the hands of the larger operators, who are able to maintain a more even output and more stable prices. The logs are graded into the following classes, as provided under Section 6 of the Royalty Act :

Cedar

No. 1—Logs 16 feet and over in length, 20 inches and over in diameter, that will cut out 50 per cent or over of their scaled contents in clear inch lumber; provided, that in cases of split timber the foregoing diameter shall not apply as the minimum diameter for this grade.

No. 2—Shingle grade. Logs not less than 16 inches in diameter and not less than 16 feet in length, that are better than No. 3 grade, but do not grade No. 1.

No. 3—Rough logs or tops suitable only for shiplap or dimension.

Culls—Logs lower in grade than No. 3 shall be classed as culls.

Fir

No. 1—Logs suitable for flooring, reasonably straight, not less than 20 feet long, not less than 30 inches in diameter, clear and free from such defects as would impair the value for clear lumber.

No. 2—Logs not less than 14 inches in diameter and over 24 feet long, or not less than 12 inches in diameter and over 24 feet, sound, reasonably straight, free from rotten knots or bunch-knots, and the grain straight enough to ensure strength.

No. 3—Logs having visible defects, such as bad crooks, bad knots, or other defects that would impair the value and lower the grade of lumber below merchantable.

Culls—Logs lower in grade than No. 3 will be classed as culls.

Spruce, Pine, and Cottonwood

No. 1—Logs 12 feet and over in length, 30 inches in diameter and over, up to 32 feet long, 24 inches if over 32 feet long, reasonably straight, clear, free from such defects as would impair the value for clear lumber.

No. 2—Logs not less than 14 inches in diameter and not over 24 feet long, or not less than 12 inches in diameter and over 24 feet long, sound, reasonably straight, free from rotten knots or bunch-knots, and the grain straight enough to ensure strength.

No. 3—Logs having visible defects, such as bad crooks, bad knots, or other defects that would lower the grade of lumber below merchantable.

Culls—Logs lower in grade than No. 3 will be classed as culls.

Diameter measurements, wherever referred to in this schedule, shall be taken at the small end of the log.

Prices of Logs

Though No. 1 fir, cedar and spruce logs have sold at as high as $15 to $17 per M. during periods of excessive demand or limited supply, and as low as $7.00, under unfavourable conditions, the average prices of logs, delivered at Vancouver, during the five years (1912-1916) were approximately as follows :

	No. 1	No. 2	No. 3	Camp run
Fir	$12.00	$9.00	$6.50	$10.00
Spruce	12.00	9.00	6.50	10.00
Cedar	13.00	8.00	6.00	9.00
Hemlock	.....	....	....	6.50
Balsam	.....	....	....	6.50

Destruction by Teredos

Storage of logs in British Columbia is a serious problem. Unless the logs can be held in fresh or brackish water, or on tide flats where they will dry out every day, they become riddled by teredos in two or three months. These marine worms are very active on the coast and cause great damage each year.

Exportation of Logs

The policy of the Provincial Government, since 1891, has been to require the manufacture of the forest products within the province, and to prohibit, as far as possible, the exportation of logs. The development of the local milling industry is, to a large extent, due to this policy. As a result, a number of firms, backed by United States capital, have established mills in the province, and the labour, and also a large part of the operating profit, have been kept in British Columbia.

There have been times, however, when the lumber cut has not kept pace with the log production, so that, unless an outlet for the surplus logs had been secured, the logging industry would have sustained serious loss, through the enforced shutting down of the camps and the destruction of the logs in the water by teredos. The loss of revenue to the province, in royalty and stumpage, resulting from the curtailment of logging, is an item of considerable importance to the administration. Such a situation having developed in August, 1914, following the outbreak of the war, the Government, by the following order-in-council, suspended the embargo on logs :

(COPY)

Approved and ordered this 26th day of August, A.D. 1914.

THOS. W. PATTERSON
Lieutenant-Governor

To His Honour the Lieutenant-Governor in Council :

The undersigned has the honour to report—

That a condition exists in the timber industry of the province which demands relief.

That there are in provincial waters and unsaleable at the present time upwards of 125,000,000 feet of fir, cedar and spruce logs.

That, as the result of the unsettled conditions attending the present European war, the saw-milling industries of the province have greatly reduced and may still further curtail their operations.

That, by reason of inability to dispose of their output, the loggers of the province find themselves unable to discharge their obligations for labour and supplies.

That, in order to secure relief from depressed conditions and avoid material damage to the surplus logs through the activity of the teredo, it becomes desirable to permit the export of all logs now cut within the province upon terms and conditions.

And to recommend that the undersigned be authorized to issue permits for the export of all timber now cut within the province upon payment of a tax in accordance with the following schedule :

	Grade 1	Grade 2	Grade 3
Cedar	$2.00	$1.50	$1.00
Fir	1.00	1.00	.50
Spruce	2.00	1.50	1.00
Pine	2.00	1.50	1.00
Hemlock	.50	.50	.50
Balsam and larch	.50	.50	.50

such tax to be deemed to include any and all royalties which may be due with respect to said timber : *Provided*, however, that no permit to export shall be given unless all taxes, royalties, or other payments due the Crown have been paid : *Provided*, further, that the privilege to export such timber may be withdrawn at any time without notice.

Dated, this 25th day of August, A.D. 1914.

W. R. ROSS
Minister of Lands

Approved, this 25th day of August, A.D. 1914.

RICHARD MCBRIDE
Presiding Member of the Executive Council

The royalty, which, at that time, was 50 cents per M. on all grades, is included in these charges. But, early in 1915, it was increased to 85 cents on the upper grades. Owing to the growing scarcity of cedar in the Pacific states, there is always a good demand for British Columbia cedar on Puget sound,

and, for No. 2 and No. 3 grades, especially, the price offered is usually considerably higher there than at home. When conditions improve, the embargo will undoubtedly again be enforced as it is in the interest of the province, as a whole, to encourage the local manufacture of all the natural resources.

Logging Operations

The number of logging operations in the province increased from 957 in 1915, to 1,144 in 1916, due largely to the increased number of handloggers' licenses issued, as a result of the opening up of the pulp-mills at Ocean Falls and Swanson Bay.

It is the aim of the provincial Forest Branch to inspect every logging operation on provincial lands at least quarterly; but, with the limited field staff available, this has been impossible of late. The main objects of these inspections are to prevent trespass, to encourage brush disposal and to keep the importance of fire protection before the operators. Except on timber sales, no attempt is made to enforce cutting regulations. On timber sales the most important consideration is the complete removal of the stand.

The following table shows the number of operations for each forest district, divided into three classes, and also the number of inspections made in each district :

LOGGING OPERATIONS AND INSPECTIONS ON PROVINCIAL LANDS, 1916

Forest District	Timber sales	Hand-loggers' licenses	Leases, licenses, Crown grants, and pre-emptions	Total operations	Number of inspections
Cranbrook	10	...	45	55	110
Fort George	10	...	83	93	52
Hazelton	...	...	4	4	4
Island	...	...	40	40	45
Kamloops	1	...	13	14	15
Lillooet	18	...	23	41	33
Nelson	14	...	91	105	156
Prince Rupert	17	200	30	7	389
Vancouver	93	91	281	5	756
Vernon	7	...	73	80	88
Totals	170	291	683	1,144	1,648

Timber Cut in British Columbia

It is impossible to secure accurate statistics as to the amount of timber which has been cut for the manufacture of lumber or other forest products. In the earlier times no attempt was made to keep track of the amount cut. Fairly accurate records have been kept for the timber cut under lease or license or from the Crown-granted lands in respect to which royalty is due; but that taken off the old Crown grants, which are free of royalty, has not been recorded until the last few years. Statistics regarding the cut on provincial lands in the interior, up to 1906, are, to a large extent, unavailable, as official scaling was not enforced. In the Railway Belt also the only records are those concerning the collection of royalty.

Output of Forest Industries

In order to secure information as to the output of the forest industries, the Dominion Forestry Branch, in 1909, commenced the collection of such data, by means of questionnaires sent out to lumbermen and wood manufacturers. From the replies secured, the Dominion Forestry Branch publishes annual bulletins on this subject. Though the data thus secured are not as complete as could be desired, owing to the failure of many lumbermen to send in their returns, the proportion of delinquents is each year decreasing, and the value of the reports is correspondingly increasing. These reports, however, do not include one very considerable item of forest production, namely, the amount of timber exported in the form of logs or pulp-wood or other unmanufactured forms. In British Columbia, the exportation of logs from Crown-granted lands has been considerable, and, since the embargo against export from Crown lands was raised in 1914, this trade has been of considerable importance.

The amount annually exported in logs for the last few years has been as follows :

1911	47,000,000 b.f.
1912	63,280,375 b.f.
1913	58,752,678 b.f.
1914	65,678,054 b.f.
1915	106,874,935 b.f.
1916	52,184,385 b.f.

The confusion resulting from inclusion, or exclusion, of various forms of forest products, such as shingle bolts, poles, piling, fence posts, ties, cordwood, etc., for which other standards of measurement than board feet are used, further complicates the compilation of these statistics. The use of the log-scale in some instances and mill-run in others presents still another difficulty.

The figures given in the following discussion of this subject must be considered in the light of this explanation, and are not put forward as absolutely accurate. They are, nevertheless, of considerable interest, as indicating the growth of the lumber industry, which, though not rapid, has been fairly steady.

During the colonial days, from 1856 to 1871, very little lumber was sawn locally. The total amount is estimated at 250,000 M. b.f. Strange as it may seem, a considerable amount of the lumber used during that period was imported from San Francisco, though dense forests of the finest timber were everywhere available. From 1871 to 1888 the lumber cut aggregated 595,000 M. b.f. Since 1888, records of the cut, on which royalty was paid to either the Dominion or Provincial Governments, are available, but complete records were not kept of the timber cut from Crown-granted land which was not subject to the payment of royalty. The following table shows the steady growth of the industry, both in number of mills and production. The variation in the number of mills reported for each year is due to the fact that a large number of them were small portable outfits, which shifted from place to place, and were included in some years and omitted in others.

LUMBER PRODUCTION

Conversion factors : 1 M. lath = 166·6 b.f.; 1 M. shingles = 100 b.f.

Calendar year	Provincial lands			Dominion lands					Total Dominion and Provincial
	Number of mills	Daily capacity	Lumber cut	Lumber cut	Lath	Shingles	Shingle bolts	Railway ties	
		M.b.f.	M.b.f.	M.b.f.	M.	M.	Cords		M.b.f.
1888	25	769	31,869	24,437	....	....	....	.....	56,306
1889	30	1,089	43,852	23,760	....	....	....	.....	67,612
1890	41	1,343	78,177	16,684*	....	....	....	.....	94,861
1891	57	1,786	88,108	32,504*	....	....	....	.....	120,612
1892	57	1,757	64,187	20,063	....	....	....	.....	84,250
1893	60	1,785	60,587	16,089	....	....	....	.....	76,676
1894	66	1,786	64,498	14,476	....	....	....	.....	78,974
1895	77	1,815	112,885	10,042	....	....	....	.....	122,927
1896	85	1,903	112,947	13,713	....	....	....	.....	126,660
1897	90	1,805	105,939	15,255	62	217	....	.....	121,226
1898	45	1,576	124,547	27,077	365	783	....	367,932	162,801
1899	45	1,506	217,086	29,684	345	4,404	....	177,077	252,580
1900	35	1,742	276,237	32,877	324	....	5,233	224,856	318,531
1901	32	1,412	241,312	33,364	1,371	....	5,568	214,588	284,182
1902	105	1,904	281,946	31,279	1,619	....	15,797	149,530	325,874
Totals			1,578,227	341,304	4,086	5,404	26,598	1,133,983	2,294,872

*Includes lumber cut from Indian Reserves.

TIMBER CUT IN BRITISH COLUMBIA, 1903–1916

Conversion factors: 1 lineal foot = 5 b.f. ; 1 cord = 500 b.f. ; 1 tie = 30 b.f.

Dominion Lands

Fiscal year	Saw material	Railway ties	Poles, piles, etc.	Shingle bolts	Cord-wood	Fence posts, rails, etc.	Lath	Total
	M.b.f.	Pcs.	M. lineal ft.	Cords	Cords	Cords	Pcs.	M.b.f.
1903–4	22,710	62,060		6,395	......	......	1,282,617	30,284
1904–5	21,368	46,969	......	7,282	......	......	697,000	26,534
1905–6	21,640	37,116	......	4,354	......	......	413,267	24,939
1906–7	42,477	44,588	......	8,698	......	......	71,500	48,176
1907–8	77,936	94,243	......	9,519	1,142	......	4,349,900	86,819
1908–9	57,211	4,902	......	19,033	1,300	2,800	1,189,500	67,725
1909–10	93,858	12,191	40,261	15,454	3,464	13,066	1,130,300	104,085
1910–11	42,867	28,763	43,942	16,798	7,119	30,215	....	55,939
1911–12	98,769	9,933	157,600	15,596	6,849	18,420	....	111,095
1912–13	128,748	86,485	160,458	13,780	6,670	46,130	....	142,416
1913–14	129,624	154,718	714,288	14,330	17,104	175,876	....	153,730
1914–15	67,642	24,274	338,680	33,680	1,281	13,990	....	87,558
1915–16	119,062	29,662	347,727	54,707	9,838	368,837	....	154,338
	923,912							1,093,638

PROVINCIAL LANDS

Calendar Year	Cut on Crown lands				Crown-grant paying manufacturing or export tax	Total	Total for Prov. and Dom.
	Saw Material	Piles, poles	Cords	Ties			
	M.b.f.	M. lineal ft.		Pcs.	M.b.f.	M.b.f.	
1903	317,551	......	......	......	Not reported	317,551	347,835
1904	270,271	......	......	......	64,422	334,693	361,227
1905	450,385	......	9,938	......	47,895	508,218	533,157
1906	476,430	......	12,348	......	50,504	539,282	587,458
1907	509,013	......	6,163	......	50,889	566,065	652,884
1908	507,706	......	4,968	......	47,690	560,364	628,089
1909	530,091	......	3,099	......	55,428	588,618	692,703
1910	774,260	5,509	113,297	8,773	......	816,278	872,217
1911	......	......	......	......	......	1,060,000	1,171,095
1912	......	......	......	......	......	1,105,394*	1,247,810
1913	......	......	......	......	......	1,457,042	1,610,772
1914	787,102	5,851	202,778	1,477,514	......	962,071	1,049,629
1915	827,633	3,732	310,486	516,723	......	1,017,038	1,171,376
1916	1,084,733	5,024	279,185	986,190	......	1,278,532	1,218,532†
					Total...	11,111,146	12,204,784

* No old Crown-grant included. † Provincial only.

The following table shows the form of provincial tenure under which the timber was cut during the years 1914-1916 :

Year	Crown grants prior to April 7, 1887			Crown grants subsequent to April 7, 1887		
	M.b.f.	Lin. ft.	Cords	M.b.f.	Lin. ft.	Cords
1914	195,440	563	44,725	191,621	1,876	113,350
1915	211,701	571	117,516	132,691	1,439	108,993
1916	247,393	1,028	89,667	173,973	2,434	124,858

Year	Pre-emptions			Timber licenses		
	M.b.f.	Lin. ft.	Cords	M.b.f.	Lin. ft.	Cords
1914	31,464	985	19,347	185,105	1,491	37,262
1915	28,185	411	7,648	155,332	777	36,136
1916	37,389	211	9,095	232,609	533	22,972

Year	Timber leases			Timber sales		
	M.b.f.	Lin. ft.	Cords	M.b.f.	Lin. ft.	Cords
1914	157,565	387	8,050	31,756	126	1,346
1915	110,343	35	4,991	76,127	66	2,782
1916	156,688	226	12,625	63,055	226	8,426

Year	Railway permits	Hand-loggers' licenses		
	M.b.f.	M.b.f.	Lin. ft.	Cords
1914	....	......	....	....
1915	3,500	......	....	....
1916	....	30,170	258	571

TOTAL

Year	M.b.f.	Lin. ft.	Cords
1914	792,951	5,428	224,080
1915	717,879	3,299	278,066
1916	941,277	4,916	268,214

Plate XXII

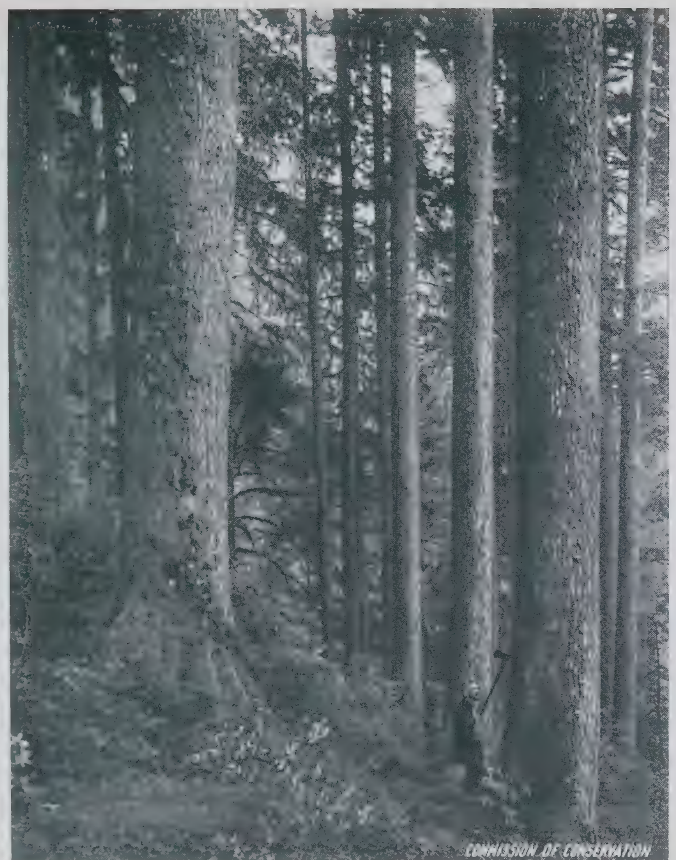


Photo. by Shields Lumber Co.

WESTERN HEMLOCK, LILLOOET LAKE

WESTERN YELLOW PINE, NICOLA VALLEY

On the basis of the reports furnished by the mills, the Dominion Forestry Branch estimates the total production of the province as follows :

Year	Lumber	Lath	Shingles	Pulpwood
	M.b.f.	M.	M.	Cords
1908	647,977	86,862	724,652	......
1909	790,601	77,487	866,275	1,316
1910	1,169,907	94,226	966,924	440
1911	1,341,942	136,461	900,126	150
1912	1,313,782	124,459	778,045	35,067
1913	1,173,647	108,859	643,484	84,173
1914	962,612	59,140	1,060,272	80,013
1915	669,816	46,345	1,894,642	90,535
1916	875,937	45,729	2,009,798	109,115

The total amount of timber cut in the province up to the year 1916 is estimated as not to exceed 30 billion feet, board measure.

Douglas fir and red cedar are by far the most important species cut, as is shown by the following statement on page 178, prepared from data collected by the Dominion Forestry Branch.

The value of the products of the forest manufactured within the province has, during the last four years, averaged $33,300,000. The value of the various products, including freight charges, within the province, during that period has been as follows :

	1913	1914	1915	1916
Lumber, Coast	$20,400,000*	$15,500,000*	$15,500,000	$21,075,000
Lumber, Interior	6,400,000	3,750,000	....	....
Pulp	3,000,000	2,730,000	3,200,000	3,520,000
Shingles	550,000†	650,000†	3,500,000	4,500,000
Boxes	....	....	750,000	1,833,000
Piles and poles	400,000	900,000	1,200,000	650,000
Mining-props and posts	250,000	300,000	400,000	1,000,000
Miscellaneous (cut by railways, mines, settlers, cordwood, etc.)	1,000,000	1,200,000	900,000	1,150,000
Additional value contributed by industries, etc.	1,000,000	1,900,000	1,750,000	1,650,000
Product of Dominion lands	450,000	1,600,000	1,800,000	‡
Lath	200,000	150,000	150,000	150,000
Totals	$33,650,000	$28,680,000	$29,150,000	$35,528,000

Since the war has disturbed the normal conditions in the lumber industry in British Columbia, the year 1913 may be taken as typical of its productive capacity. In this connection, *Market Bulletin, No. 9*, issued by the British Columbia Forest Branch, is particularly instructive. This Bulletin contains detailed information concerning the various forest products of this province during the years 1913 and 1914.

Saw and Shingle Mills in British Columbia

In 1916, there were approximately 390 mills in the province which manufactured either lumber or shingles. It is estimated that, if operated to capacity,

* Includes shingles cut from logs.
† Includes shingles cut from bolts only.
‡ Included in other items.

TOTAL CUT OF LUMBER AND SHINGLES, BY SPECIES, IN BRITISH COLUMBIA, 1914 TO 1916

Kind of wood	No. of active mills reporting			Quantity			Per cent of total cut	Total value	Average value per M.b.f.		
	1914	1915	1916	1914	1915	1916	1916	1916	1914	1915	1916
				M.b.f.	M.b.f.						
Douglas fir	138	129	145	601,412	453,415	574,382	65·6	$8,067,168	$11.32	$11.76	$14.04
Spruce	70	49	48	73,712	56,360	49,077	5·6	719,687	12.04	13.60	14.66
Western red cedar	94	68	68	93,970	54,666	78,935	9·0	1,490,685	10.30	17.95	18.88
Western yellow pine	39	43	43	34,616	35,166	92,698	10·6	1,455,396	13.39	13.02	15.70
Western larch	36	35	43	59,029	28,023	36,651	4·2	575,037	11.61	12.92	15.69
Western hemlock	52	45	36	31,116	24,959	28,051	3·2	392,674	11.01	11.44	14.00
Western white pine	26	23	23	14,765	7,664	5,021	0·6	81,048	14.32	15.51	16.14
Lodgepole pine	10	4	9	7,041	4,207	7,242	0·8	102,758	12.51	13.48	14.19
Balsam	12	16	14	13,701	3,276	1,266	0·1	17,046	12.62	8.28	13.46
Cottonwood	8	7	7	7,149	1,110	2,336	0·3	28,240	13.39	9.86	12.09
Yellow cypress	1	8	4	19	880	271	*	2,893	25.00	14.58	10.68
Birch	3	1	..	22	50	7	*	....	20.00	40.00	.....
Maple	3	1	2	54	40	....	*	79	38.91	20.00	11.29
Red alder	1	..	..	6	....	....	*	....	15.00	.....	.....
Total lumber	172	238	234	936,612	669,816	875,937	100·0	$12,932,711	$11.45	$12.56	$14.76
Cedar shingles, M.	..	..	..	1,060,272 M.	1,894,642 M.	2,009,798 M.	....	$4,019,197	$1.94 Per M.	$1.71 Per M.	$2.00 Per M.

* Less than one-tenth of 1 per cent.

these mills could turn out about 2,500,000 M.b.f., which is over twice as much as they have done in any of the last few years. In spite of this fact, new mills are being constructed every year. Over 60 per cent of the mills are situated on the coast, and they manufacture 85 per cent of the total cut. Vancouver and vicinity, which includes New Westminster, is the largest milling centre. Nearly 75 per cent of the lumber and shingle production of the province is in that district.

The following table shows the distribution of the saw and shingle mills throughout the province :

SAW AND SHINGLE MILLS IN BRITISH COLUMBIA, 1916

District	Up to 15 M. feet daily capacity	15 M. to 40 M. feet daily capacity	Over 40 M. feet daily capacity	Shingle-mills	Total
Cranbrook	7	6	16	1	30
Fort George	5	10	1	..	16
Hazelton	7	1	..	1	9
Kamloops	2	3	4	1	10
Lillooet	20	..	..	..	20
Nelson	10	7	9	11	37
Tête Jaune	1	1	1	..	3
Vernon	9	12	4	..	25
Totals, east of 'Cascades'	61	40	35	14	150
Island	22	13	14	12	61
Vancouver	36	35	32	66	169
Prince Rupert	3	5	1	1	10
Totals, west of 'Cascades'	61	53	47	79	240
Totals in province	122	93	82	93	390

Pulp Industry

Pulp and paper manufacture has been established on a commercial basis only since 1912. As yet, only five pulp-mills have been established, and these are all situated on the coast. The first plant was started at Port Mellon, on Howe sound, in 1909, but did not develop beyond the experimental stage, and has been shut down for several years. The building of this mill was followed by others at Mill Creek, Swanson Bay, Powell River and Ocean Falls. A sixth is being constructed at Quatsino Sound, on the west coast of Vancouver island. Two of these plants, the Swanson Bay and Ocean Falls, are situated on the northern coast, while the other two are in the southern portion.

The Swanson Bay plant was built by the Canadian Pacific Sulphite Pulp Co., Ltd., British capital being behind the enterprise. The company was later reorganized as the Swanson Bay Forests, Woodpulp and Lumber Mills, Ltd. The plant was shut down for several years but was re-opened in 1916, under the name of the Empire Pulp and Paper Mills. It has since been taken over by the Whalen Pulp and Paper Co., which controls the pulp-mills at Mill Creek and Quatsino Sound. This is a sulphite plant with a capacity of

about 30 tons per day. There is a saw-mill in connection, in which the higher grades of logs are manufactured into lumber. The plant is situated in the centre of an immense pulpwood area, all of which is tributary to the plant by protected waterways. In connection with the plant, 84,180 acres of timberland is held under pulp lease. The operation of this pulp-mill means much to the development of the northern portion of the province, not only by supplying employment to the local population, but by providing a market for the timber on lands which are available for settlement. Much of the timber in this vicinity is not suitable for lumber, but can be used for pulp. The presence of a market for this timber will greatly facilitate the exploitation of the saw-material.

The Ocean Falls plant is situated on Cousins inlet, which is a branch of Dean channel, about 180 miles south of Prince Rupert and 300 miles north of Vancouver. The original company, Ocean Falls Co., Ltd., was financed largely in England, but it has been now taken over by San Francisco capitalists under the name of Pacific Mills, Ltd. This is a ground pulp plant, with an original capacity of 150 tons per day. A saw-mill, with 300 M. per day capacity, is operated in conjunction with the pulp-mill. The new owners have greatly improved the mill and have installed paper-making machinery. Pulp leases covering 80,000 acres are held by this company, and there are also vast supplies of pulp-wood on other lands in the vicinity. The coast is indented with long navigable inlets, which afford safe and easy means of transporting logs to the mills.

The Powell River mill is situated at the outlet of Powell river, on Malaspina strait, about 80 miles north-west of Vancouver. It was built by the Powell River Paper Co., which was composed of interests connected with the Brooks-Scanlon Lumber Co. of Minneapolis. It is now known as the Powell River Co. It has been operated continuously since its completion, and is one of the most thriving industries in the province. Both the sulphite and mechanical processes are used to reduce the wood to pulp, which is manufactured into paper at this plant. The capacity of the mill is about 250 tons of paper per day. The operating company acquired the mill site, water-power and 134,500 acres of timber in pulp leases, from the Canadian Industrial Co. These leases are nearly all situated about 100 miles north of the mill, as the timber in the immediate vicinity is chiefly of the Douglas fir-red cedar type. The logs can, however, be safely and cheaply towed to the mill through the channels protected by Vancouver island. This mill, in addition to its own cut, uses a considerable amount of pulp-wood purchased from independent loggers, whose main cut is for lumber purposes.

One of the most successful plants is that of the British Columbia Sulphite Fibre Co., which is situated at Mill Creek on Howe sound. As the name implies, sulphite pulp only is produced, and no paper is manufactured. This plant has been operating steadily since its completion in 1912, and has a capacity of about 40 tons per day. As none of the old pulp leases were appurtenant to this mill, it has depended for its supply of pulp-wood on purchasing logs from independent operators; this has provided a useful market for hemlock

Base map from plate of Map of Dominion of Canada, Dept. of Interior

and balsam, which would otherwise have been wasted. Within the last few years, the company has taken advantage of the provisions for timber sales and has acquired a considerable amount of pulp timber under what are known as 'pulp licenses'.

At Quatsino sound, on the west coast of Vancouver island, a sulphite pulp-mill, with a daily capacity of 70 tons, is being erected by the Colonial Pulp and Paper Mills. This company, with the Empire Pulp and Paper Co., and the British Columbia Sulphite Fibre Co., is being merged in the Whalen Pulp and Paper Co. It is proposed to erect a saw-mill with a daily capacity of 150 M. in connection with the pulp-mill, to utilize the fir and cedar and better grades of spruce for the manufacture of lumber. The Colonial Pulp and Paper Co. controlled 55,679 acres in pulp leases, which was held for a number of years without development.

The growth of the wood-pulp industry in British Columbia is illustrated by figures secured by the Forestry Branch of the Department of the Interior. Reports were evidently not secured from the Swanson Bay and Ocean Falls plants when they were in operation.

	No. of active mills	Pulpwood used, cords	Average value per cord
1909	1	1,316	$7.44
1910	1	440	5.00
1911	1	150	7.60
1912	2	35,067	5.51
1913	2	84,173	4.77
1914	2	80,013	5.33
1915	2	90,535	6.08
1916	2	108,997	5.32

The output of the two active mills during 1914-1916 has been as follows :

	Sulphite wood-pulp	Paper
1914	10,698 tons	45,816 tons
1915	13,000 "	50,307 "
1916	14,389 "	65,229 "

With the re-opening of the two northern plants and the completion of the one at Quatsino sound, the pulp and paper industry will materially increase the forest production in this province.

Aside from the abundance of timber for pulp-wood, British Columbia offers exceptional water-power facilities for the development of the pulp and paper industry. The mild climate of the coast region permits of continuous operation throughout the year, and the harbours remain open to navigation. As the streams are fed, during the summer, to a large extent, from melting snow and ice on the mountain tops, and, in the winter by heavy rain, the flow is sustained.

Subsidiary Industries

The wood-working industries have not been developed in British Columbia to the extent which might be expected, in a region where the raw materials

are so abundant and so cheap. This may be attributed, in part, to the small local population; but, undoubtedly, sufficient effort has not been made to establish them. The lack of hardwood shuts out such industries as furniture and wagon manufacture, but there are considerable suppplies of maple and cottonwood which might be exploited for these purposes. The number and importance of the subsidiary forest industries are, however, steadily increasing, the principal products being sash and doors, boxes, cooperage, wooden pipe, veneer and creosoted products, such as wood-block paving, ties, piles and poles.

British Columbia Forest Branch *Bulletin No. 19* gives a list of 16 firms manufacturing sash and doors, 47 making boxes, 7 cooperage, 5 veneer and 2 creosoting plants. There are in addition two or three wood-pipe factories. During 1907 and 1908, one or more firms put ready-made houses on the market.

Closer Utilization

The extension of these industries is of great importance from the standpoint of conservation, since, as a rule, they provide a use for grades and sizes of wood which cannot be profitably marketed as lumber.

Manufacturing Waste

The waste in the manufacture of lumber in this province is appalling to one accustomed to more conservative methods. Huge slabs of absolutely clear wood, 3 to 6 inches thick, are sent to the fuel pile, and ends of boards and timbers which could well be used for some purpose are sent to the refuse burner. The burner is the most conspicuous thing about a British Columbia saw-mill. The fire never goes out and it furnishes a pillar of flame by night and a cloud of smoke by day. Heavy saws are necessary to 'break down' the large logs, but it is not unusual to see one-inch lumber being cut with a saw that takes out a ⅜-inch to ½-inch kerf. It is estimated that at least 25 per cent of the tree is left in the woods and another 30 to 35 per cent is wasted in the mill.

That closer utilization is profitable has been demonstrated beyond question by some of the more progressive manufacturers in the Pacific states. In a number of mills in California, short ends and blocks are worked up into stock for the manufacture of beehives, incubators, etc., thereby saving a large amount of material, which, in British Columbia, goes into the burner.

A campaign against waste in the lumber industry is urgently needed. A large and profitable field for research is open in this direction. The possibilities of extracting from saw-mill waste such articles of commerce as turpentine, oils, acetic acid and alcohol, call for immediate investigation. Now that large quantities of hemlock are being used for pulp and lumber, an effort should be made to use the bark for tanning purposes.

If the principles of forestry are ever to be adopted in this province, closer utilization must be practised. Intensive manufacture will result in enhanced stumpage values, which, in turn, will render the forest worth protecting and worth reproducing.

Logging Regulations

No attempt is being made by either the Dominion or Provincial Government to regulate the cutting operations along silvicultural lines, except on

the timber sales. Though, in the issuance of both the Dominion and provincial timber licenses, the respective governments reserve the right to impose such cutting regulations as are deemed desirable for silvicultural purposes, no steps have been taken in this direction. In provincial timber sales, the contracts explicitly call for utilization of all merchantable timber down to stated stump and top diameters, leaving of seed trees if designated, protection of the young growth, and disposal of slash as directed by the District Forester. Similar provisions are made in the timber sales on Dominion forest reserves.

In some places, such as in the fir forests on the coast, good reproduction is secured by clean cutting and slash burning, and, if seed trees were left, they would, in many instances, be blown down. The protection of the established young growth is very difficult where the logs are taken out by donkey engines. Usually the volunteer growth which comes up under the main stand in the Douglas fir-cedar type is predominantly hemlock, consequently the protection of the young growth is not always desirable. On the other hand, conditions in many parts of the interior are such that careful regulation of the cutting is necessary if successful reproduction of the more valuable species is to be secured.

Clean cutting is perhaps the most important silvicultural objective on the coast. Partial logging results not only in the waste of a large amount of timber—for what is left on the ground is usually burned or blown down—but it insures to a large extent the reproduction of inferior species, and leaves diseased and insect-infested trees as a menace to the surrounding and succeeding forest. It is in recognition of this fact that the government charges a lower rate of royalty on balsam and hemlock and on the lower grades of other species.

Losses on Lower Grades

Unless specifically required, as in the case of timber sales, the extent to which the timber is used is dependent to a very large extent on the price of logs. The statement on page 184 illustrates the effect of a difference of $1 per M. in the price of logs, not only on the profit of the logger, but on the timber he can take out without financial loss. The example taken is that of an average good limit on the coast, where the stumpage, in addition to the royalty, costs the logger $1 per M.

This shows that, with logs selling at an average price of $9.56 per M. the logger can take out all the timber, pay the government $16,900 in royalty, and make a profit of $28,350. The price of logging the small and 'limby' logs in the lower grades is slightly higher per M. than for the large logs. If the price of logs is reduced $1 per M. on each grade, the cost of logging and royalty would exceed the price that could be obtained for the No. 3 grades of fir and cedar or for the hemlock and balsam. The natural result would be that, rather than stand a loss of $7,500 in handling it, the logger would leave the 10,000 M. included in these grades in the woods. In some such cases the profits on the other grades will more than offset this loss, but in others it will not; and, if forced to take out the lower grades, the logger would sustain a net loss on his operation. It is of interest to note also that the waste of the low grades in the example given would mean a loss in royalty to the government of $5,000 and, in loggers' wages, of about $50,000.

Species	Grade	Amount M.b.f.	Logging cost		Royalty		Average price of logs $9.56 per M.			Average price of logs $8.56 per M.			
			Per M.	Total	Per M.	Total	Price of logs Per M.	Net stumpage, per M.	Profit	Price of logs per M. (reduced $1 per M.)	Net stumpage, per M.	Profit on upper grades	Loss on lower grades
Fir.........	1	5,000	$6.50	$32,500	$0.85	$4,250	$12.00	$4.65	$23,250	$11.00	+$3.65	$18,250	......
"	2	4,000	6.50	26,000	.85	3,400	9.00	1.65	6,600	8.00	+ .65	2,600	......
"	3	2,000	6.75	13,500	.50	1,000	7.50	.25	500	6.50	− .75	......	$1,500
Cedar.......	1	2,000	6.75	13,500	.85	1,700	14.00	6.40	12,800	13.00	+ 5.40	10,800	......
"	2	3,000	6.75	20,250	.85	2,550	10.00	2.40	7,200	9.00	+ 1.40	4,200	......
"	3	2,000	7.00	14,000	.50	1,000	7.75	.25	500	6.75	− .75	......	1,500
Hemlock....	..	4,000	6.75	27,000	.50	2,000	7.50	.25	1,000	6.50	− .75	......	3,000
Balsam......	..	2,000	6.75	13,500	.50	1,000	7.50	.25	500	6.50	− .75	......	1,500
Total...	..	24,000	$6.68	160,250	.70	16,900	$9.56	$2.17	$52,350	$8.56	$1.17	$35,850	$7,500
Purchase price of stumpage..							......	1.00	24,000	....	1.00	24,000	......
Net returns from operation........							......	$1.17	$28,350	....	$0.17	$11,850	$7,500
										Net profit if lower grades are not used........................			$11,850
										Net profit if lower grades are used.			4,350
										Loss in taking out lower grades at this price....................			$7,500

The extent to which silvicultural regulations can be put into practice is dependent, therefore, on the net value of stumpage, which in turn is, to a large extent, governed by the price of the forest products.

Stumpage Values

What may be termed the 'gross stumpage value' is the value of standing timber, including any royalty or manufacture tax which may be reserved by the government, as well as the equity of the owner or holder of the cutting rights. For the purpose of this discussion the term is used in the restricted sense of 'net stumpage value', as it is ordinarily used in the trade. This includes only the value of the standing timber over and above the royalty or tax which may be due to the government at the time of cutting. The Provincial Government makes this distinction in its timber sales, *viz.*, that the bonus paid by the purchaser in addition to the royalty is referred to as the stumpage value.

There are two ways of determining the stumpage value. In the first, the absolute stumpage value may be considered to be the net amount that can be secured after the cost of manufacture is deducted from the price of finished lumber. The second, and more usual application, is to consider stumpage value as the price at which standing timber can be sold. The former depends on only two factors, cost of exploitation and price of product; the latter, though affected greatly by these factors, is influenced by supply and demand, the prevailing financial situation and the vagaries of speculative investment. A margin of safety is always allowed between these two values to cover operating profits, carrying charges, interest and risk of loss.

Though knowledge of the available supply of timber of any kind is generally a dominant factor in determining the sale value of stumpage, in British Columbia the supply on the market is so large that stumpage values are governed almost entirely by the cost of exploitation and the price of the manufactured products. While subject to many local variations, due to differences in stand and location, the average sale values of stumpage, exclusive of royalty or manufacture tax, in British Columbia, in 1916, were approximately as follows:

	Douglas fir	Western red cedar	Hemlock	Balsam	Spruce	Western white pine	Western yellow pine	Western larch
Southern Mainland Coast	$1.00	$1.25	$0.50	$0.40	$1.50	$1.00	....	....
Vancouver Island Crown Grant	2.00	2.25	.60	.50	2.00	2.00	....	....
Northeastern Vancouver Island	1.00	1.25	.40	.40	1.00	1.00	....	....
West Coast Vancouver Island	.50	.50	.25	.25	.50	.50	....	....
Northern Mainland	....	.50	.35	.35	.50	....	....	....
Queen Charlotte Island	....	.50	.35	....	.50	....	....	....
Northern Interior	.40	.50	.35	.30	.50	....	....	....
Southern Interior	.75	1.00	.30	.30	.75	.75	$1.00	$1.00

As a general rule, Dominion licensed timber is held at from 25 cents to 50 cents per M. higher than provincial licensed timber, partially on account of the proximity to transportation, but chiefly because of the lower ground rent and royalty and the sense of security in the title, which the provincial licenses until recently lacked. The Crown grant timber in the Esquimalt and Nanaimo Railway grant, on Vancouver island, is more valuable on account of having the privilege of exporting the logs to United States mills, and also because there are no royalty charges on the timber cut. Spruce stumpage is abnormally high at present, owing to the demand for spruce for airplane manufacture, but it is ordinarily about the same price as fir. As high as $3 per M. has been paid for fir and cedar stumpage on Crown grant and Dominion timber berths, which offered exceptional facilities for logging, but, as a rule, an average price of $1 per M. will purchase good accessible tracts, held under lease or license, within 200 miles of Vancouver. The average sale value of all the alienated timber in the province would probably not exceed 50 cents per M. The government, therefore, retains, in the royalty, at least a half interest in the timber on Crown lands.

The prices paid on provincial timber sales, as quoted below, are generally above the prices asked by private holders. This is due to the fact that payments to the Government are made as and when the timber is cut and the government assumes all the risk of loss of the stumpage from fire, whereas the private owners usually require the sale to be made outright and a considerable cash payment to be made before permitting a purchaser to commence logging. The tracts disposed of by the government have, for the most part, been small and cheaply logged :

STUMPAGE PRICES SECURED IN ADDITION TO ROYALTY IN PROVINCIAL TIMBER SALES

Species	1914		1915		1916	
	M.b.f.	Average price per M.	M.b.f.	Average price per M.	M.b.f.	Average price per M.
Douglas fir	25,224	$1.32	29,417	$ .95	36,261	$1.00
Red cedar	14,596	1.12	27,074	1.05	44,016	1.16
Spruce	1,018	1.33	4,284	.71	11,741	.72
Hemlock	6,159	.52	23,347	.46	24,174	.45
Balsam	215	.58	8,135	.48	8,637	.39
Western white pine	223	.80	155	.77	2,459	1.69
Western yellow pine	......	....	......	....	4,074	1.74
Western larch	639	1.82	2,013	.50	2,705	1.75
Other species	531	.50	130	.50	2,287	1.95
Totals	48,605	$1.15	94,555	$0.80	136,354	$0.96

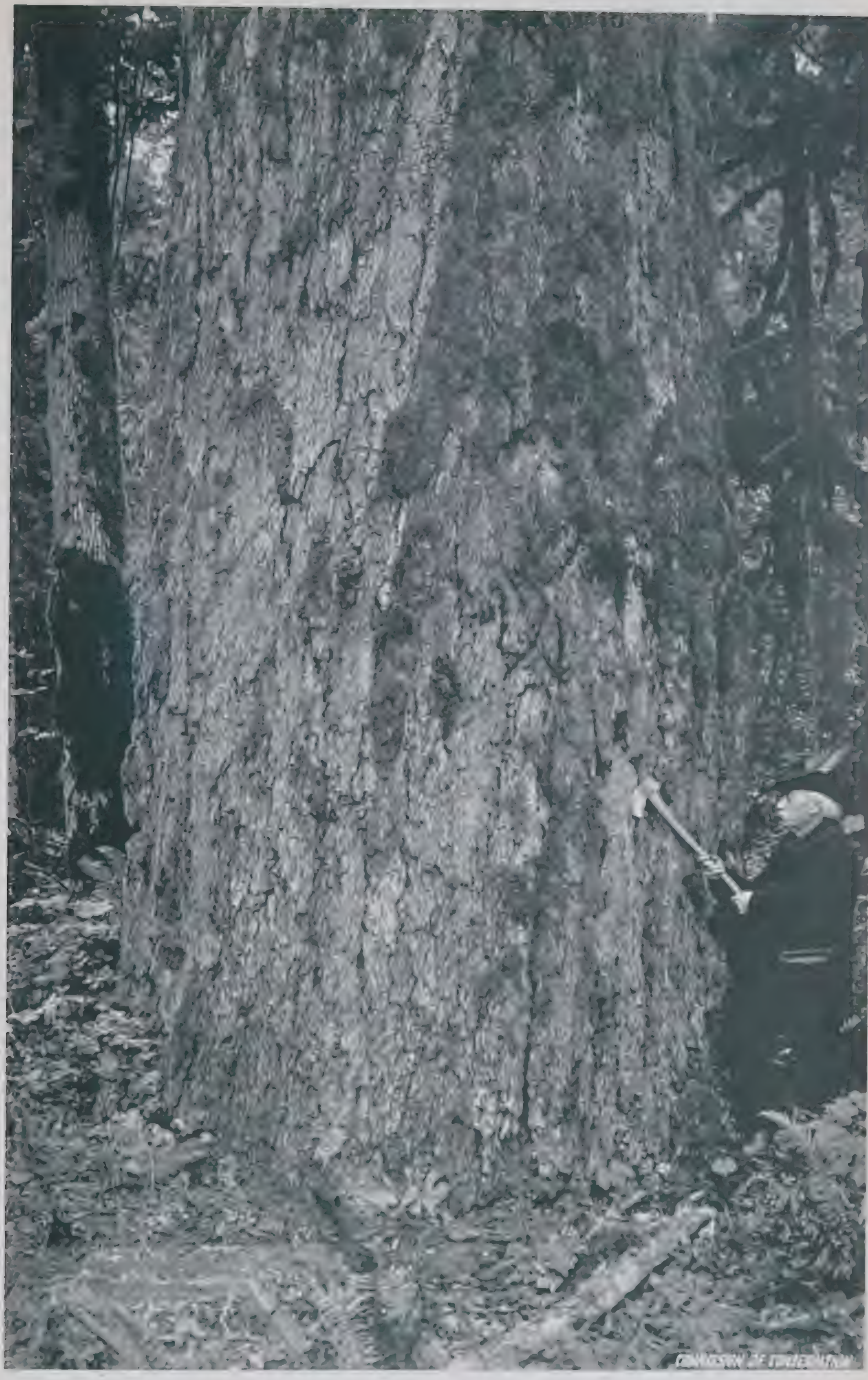


Photo. by Shields Lumber Co.

DOUGLAS FIR, NEAR CHILLIWACK

CHAPTER IX

Forest Trees in British Columbia

THE forests in British Columbia are predominantly coniferous. Deciduous trees form but a small proportion of the stand, and black cottonwood is the only species used to any extent, except for fuel. Broad-leaf maple, alder and aspen are, perhaps, the only other deciduous species of any commercial value. Notwithstanding the wide range of climatic and physiographic conditions, which produce very distinct types in different parts of the province, the number of tree species is comparatively small, about 22 coniferous and 26 deciduous species. The trees of commercial value include sixteen conifers and one deciduous tree, the cottonwood.

It is not the intention in this report to enter into a botanical discussion of the arborescent flora, but a few of the characteristic features of the more important species will be described.* The information available in regard to distribution of the various species is fragmentary and incomplete. On the accompanying maps an attempt has been made to delimit the distribution of the more important species. This must not be interpreted as indicating exactly the distributional area, inasmuch as local influences, such as altitude and climatic conditions, are more important than geographical influences in determining the distribution of a species.†

Much confusion has resulted from the use of different botanical and common names for the same species.‡ The nomenclature followed in this report is that used by the Dominion Forestry Branch and, with one exception, by the U.S. Forest Service, and is in accordance with the rules laid down by the Botanical Congress, Vienna, 1905. Trade names are frequently coined with the object of facilitating the sale of the manufactured products. Such names as hemlock-spruce and Alaska pine have been given to the western hemlock in an attempt to dissociate it from its inferior eastern relative. The various species of the genus *Abies*, though they are true firs, are known as larch in British Columbia and as balsam in eastern Canada. Since the name *fir* is so generally attributed to Douglas fir, it has been thought advisable to refer to the species of *Abies* generally as balsam. Western yellow pine is known variously as yellow pine, white pine, bull pine and western soft pine in the different regions in which it grows. The last name is a recent British Columbia coinage. It appears to be meeting with some success in the trade, but, as yet, is too limited in use to replace the widely accepted name, western yellow pine.

*For botanical description, see *Forest Trees of the Pacific Slope*, George B. Sudworth, published by U.S. Forest Service, and *Manual of the Trees of North America*, Charles S. Sargent, Houghton Mifflin Co., New York and Boston.

† The assistance rendered by Jas. M. Macoun, C.M.G., Biologist of the Geological Survey, and by the members of the Dominion and Provincial Forest Services, is gratefully acknowledged.

‡ See *Check List of the Forest Trees of the United States, Bulletin No. 17*, Division of Forestry U.S. Dept. of Agriculture.

Species of forest trees in British Columbia, subdivided into coniferous and deciduous, are as follows :

CONIFEROUS

Common name	*Botanical name*
Douglas fir*	*Pseudotsuga mucronata*
Western red cedar*	*Thuya plicata*
Yellow cypress*	*Chamæcyparis nootkatensis*
Sitka spruce*	*Picea sitchensis*
Engelmann spruce*	*Picea Engelmanni*
White spruce*	*Picea canadensis*
Black spruce*	*Picea mariana*
Balsam { Lowland fir*	*Abies grandis*
Balsam { Amabilis fir*	*Abies amabilis*
Balsam { Alpine fir*	*Abies lasiocarpa*
Western white pine*	*Pinus monticola*
Western yellow pine*	*Pinus ponderosa*
White bark pine	*Pinus albicaulis*
Limber pine	*Pinus flexilis*
Lodgepole pine*	*Pinus contorta*
Western hemlock*	*Tsuga heterophylla*
Mountain hemlock	*Tsuga Mertensiana*
Western larch*	*Larix occidentalis*
Alpine larch	*Larix Lyallii*
Tamarack*	*Larix laricina*
Western yew	*Taxus brevifolia*
Rocky Mountain juniper	*Juniperus scopulorum*

DECIDUOUS

Garry oak	*Quercus Garryana*
Madrona	*Arbutus Menziesii*
Broad-leaf maple	*Acer macrophyllum*
Vine maple	*Acer circinatum*
Dwarf maple	*Acer glabrum*
Aspen	*Populus tremuloides*
Balm-of-gilead	*Populus balsamifera*
Black cottonwood*	*Populus trichocarpa*
Paper birch	*Betula papyrifera*
Western birch	*Betula occidentalis*†
Alaska birch	*Betula alaskana*
Mountain birch	*Betula fontinalis*
Mountain alder	*Alnus tenuifolia*
Red alder	*Alnus oregona*
Sitka alder	*Alnus sitchensis*
White alder	*Alnus rhombifolia*
Oregon crab apple	*Malus rivularis*
Western serviceberry	*Amelanchier alnifolia*
Black haw	*Cratægus brevispina*
Bitter cherry	*Prunus emarginata*
Western choke-cherry	*Prunus demissa*
Western dogwood	*Cornus Nuttallii*
Western black willow	*Salix lasiandra*
Long-leaf willow	*Salix fluviatilis*
Hooker willow	*Salix Hookeriana*
Silky willow	*Salix sitchensis*

* Commercial species.

† *Betula occidentalis* is now treated as a variety of *Betula papyrifera* by most British and American botanists (see p. 216).

The province may be divided into ten regions, in which the flora is more or less distinct. The following is an attempt that has been made to present a list of the tree species which occur in each region, arranged approximately in the order of their importance, those with an * being commercial species :

COAST

1. *Southern Coast—Vancouver island and adjacent western slope of the Coast mountains :*

Douglas fir*	Madrona
Western red cedar*	Western birch
Western hemlock*	Paper birch
Lowland fir*	Western yew
Amabilis fir*	Sitka alder
Western white pine*	White alder
Yellow cypress*	Mountain alder
Sitka spruce*	Oregon crab-apple
Black cottonwood*	White-bark pine
Aspen	Rocky mountain juniper
Broad-leaf maple	Western serviceberry
Red alder	Western choke-cherry
Garry oak	Bitter cherry
Vine maple	Hooker willow
Lodgepole pine	Silky willow
Mountain hemlock	Long-leaf willow
Western dogwood	Dwarf maple

2. *Northern Coast—Western slope of the Coast mountains, from Queen Charlotte sound to Stikine river :*

Western hemlock*	Red alder
Western red cedar*	Broad-leaf maple
Sitka spruce*	Western yew
Amabilis fir*	Mountain alder
Alpine fir*	Western choke-cherry
Yellow cypress*	Western serviceberry
Black cottonwood*	Oregon crab-apple
Mountain hemlock	Silky willow
Lodgepole pine	Long-leaf willow
Aspen	Dwarf maple
Sitka alder	

3. *Queen Charlotte islands :*

Western hemlock*	Broad-leaf maple
Sitka spruce*	Aspen
Western red cedar*	Western serviceberry
Yellow cypress*	Oregon crab-apple
Lodgepole pine	Silky willow
Mountain hemlock	Long-leaf willow
Western yew	Mountain alder
Red alder	Western birch

INTERIOR

4. *Northern part of Fraser Plateau—Upper Stikine drainage to the northern boundary of the province, west of the Rocky mountains :*

White spruce*	Black spruce*
Lodgepole pine*	Alpine fir*

Western hemlock*
Black cottonwood*
Mountain hemlock
Aspen
Balm-of-Gilead
Mountain alder
Sitka alder
Western serviceberry
Long-leaf willow
Alaska birch
Dwarf maple

5. *Skeena Plateau—Drainages of Skeena, Finlay, Nechako and Blackwater rivers:*

Engelmann spruce*
White spruce*
Black spruce*
Lodgepole pine*
Douglas fir*
Black cottonwood*
Mountain hemlock
Aspen
Alpine fir
Balm-of-Gilead
Rocky Mountain juniper
Mountain alder
Sitka alder
Western serviceberry
Black haw
Mountain birch
Western birch
Dwarf maple
Long-leaf willow

6. *Northern part of the Interior Plateau—Drainage of Chilcotin river and east of Fraser river to Quesnel Forks:*

Douglas fir*
Lodgepole pine*
Engelmann spruce*
Alpine fir*
Black cottonwood*
Aspen
Balm-of-Gilead
Rocky mountain juniper
Mountain alder
Western serviceberry
Western choke-cherry
Dwarf maple
Long-leaf willow
Western birch

7. *Southern part of the Interior Plateau—Kettle river, Okanagan, Nicola, Kamloops Ashcroft and Clinton:*

Western yellow pine*
Douglas fir*
Lodgepole pine*
Englemann spruce*
Western larch*
Alpine fir*
Western white pine*
Black cottonwood
Alpine larch
White-bark pine
Aspen
Rocky mountain juniper
Western serviceberry
Mountain alder
Bitter cherry
Western choke-cherry
Dwarf maple
Long-leaf willow
Western birch

8. *Kootenay—Kootenay river and Arrow lakes:*

Western yellow pine*
Douglas fir*
Western hemlock*
Engelmann spruce*
Western larch*
Western red cedar*
Western white pine*
Alpine fir*
Lowland fir*
Lodgepole pine*
Black cottonwood*
Aspen
White-bark pine
Mountain hemlock
Alpine larch
Rocky mountain juniper
Western yew
Mountain alder
Sitka alder
Western serviceberry
Black haw
Bitter cherry
Western choke-cherry
Dwarf maple
Western black willow
Long-leaf willow
Western birch

9. *Interior Wet Belt—Shuswap lake and river, Big Bend of the Columbia river, Quesnel lakes, upper waters of Fraser river and the headwaters of the Parsnip river:*

Douglas fir*
Western red cedar*
Engelmann spruce*
Alpine fir*
Western hemlock*
Western white pine*
Lodgepole pine*
Black cottonwood*
Aspen
Mountain hemlock
White-bark pine
Rocky mountain juniper
Western birch
Mountain birch
Mountain alder
Sitka alder
Western serviceberry
Bitter cherry
Western choke-cherry
Dwarf maple
Long-leaf willow

10. *Great Plains—north-eastern corner of the province, east of the Rocky mountains:*

White spruce*
Engelmann spruce*
Lodgepole pine*
Black spruce
Aspen
Balm-of-Gilead
Black cottonwood
Tamarack
Alpine fir
Alaska birch
Long-leaf willow

The altitudinal range of the different species of trees varies in different parts of the province. In the southern interior portion of the province, they grow to higher altitudes than on the coast; and, as a general rule, the farther north any species occurs the more limited its altitudinal range. In the Kootenay district good stands of Engelmann spruce and alpine fir are found at 6,000 feet above sea level. On the southern coast merchantable timber of these species seldom grows at even 4,000 feet.

In the following table are given the maximum altitudes at which the various species, in sizes of commercial value, are reported to occur in different districts on the coast:

	Douglas fir	Western red cedar	Western hemlock	Balsam*	Sitka spruce	Yellow cypress	Western white pine	Lodge-pole pine
	feet	feet	feet	feet	feet	feet	feet	feet
Howe sound......	3,000	3,800	4,000	4,000	2,200	5,000	3,000	500
Bute inlet........	2,000	3,000	3,000	3,500	1,500	4,000	2,000	500
Kingcome inlet....	....	2,500	2,500	2,500	1,800	3,500	2,500	1,000
Renfrew district...	2,500	3,000	3,500	3,500	1,000	4,000	3,000	500
Clayoquot sound..	3,000	4,000	4,000	4,000	1,500	4,000	2,500	500
Quatsino sound....	2,500	3,000	3,500	3,500	1,000	4,000	2,500	500
Johnston strait....	2,500	3,500	3,500	3,500	1,000	4,500	3,500	200
Rivers inlet.......	2,500	4,000	3,500	4,000	700	4,000	....	200
Gardner canal.....	500	2,000	2,000	2,000	500	3,000	....	500
Skeena river......	....	1,500	1,500	1,500	800	2,500	....	800
Portland canal....	....	1,500	1,500	1,500	800	2,500	....	800
Queen Charlotte islands.........	....	2,500	2,700	....	1,400	2,500	....	800

* Amabilis fir, lowland fir and alpine fir are not distinguished, but lowland fir probably does not reach over 1,000 feet and amabilis fir 3,000 feet altitude.

Douglas Fir—(*Pseudotsuga mucronata* [Raf.]—Sudworth)

This species has been called by botanists *Pseudotsuga taxifolia* (Lam.)—Britton, and *Pseudotsuga Douglasii* (Carr), and it has even been assigned to the genera *Abies* and *Pinus* by some of the early botanists. A great variety of common names is attached to it. In the export trade of the Pacific states it is known as Oregon pine. In British Columbia it is, as a rule, simply called fir. Two varieties, yellow fir and red fir, are sometimes recognized. The former is the product of the most favourable sites, and is characterized by a yellowish, flakey bark, but slightly furrowed. The wood of the yellow fir is lighter and softer than that of the red fir, owing to the fact that the summer-wood rings are not so prominent.

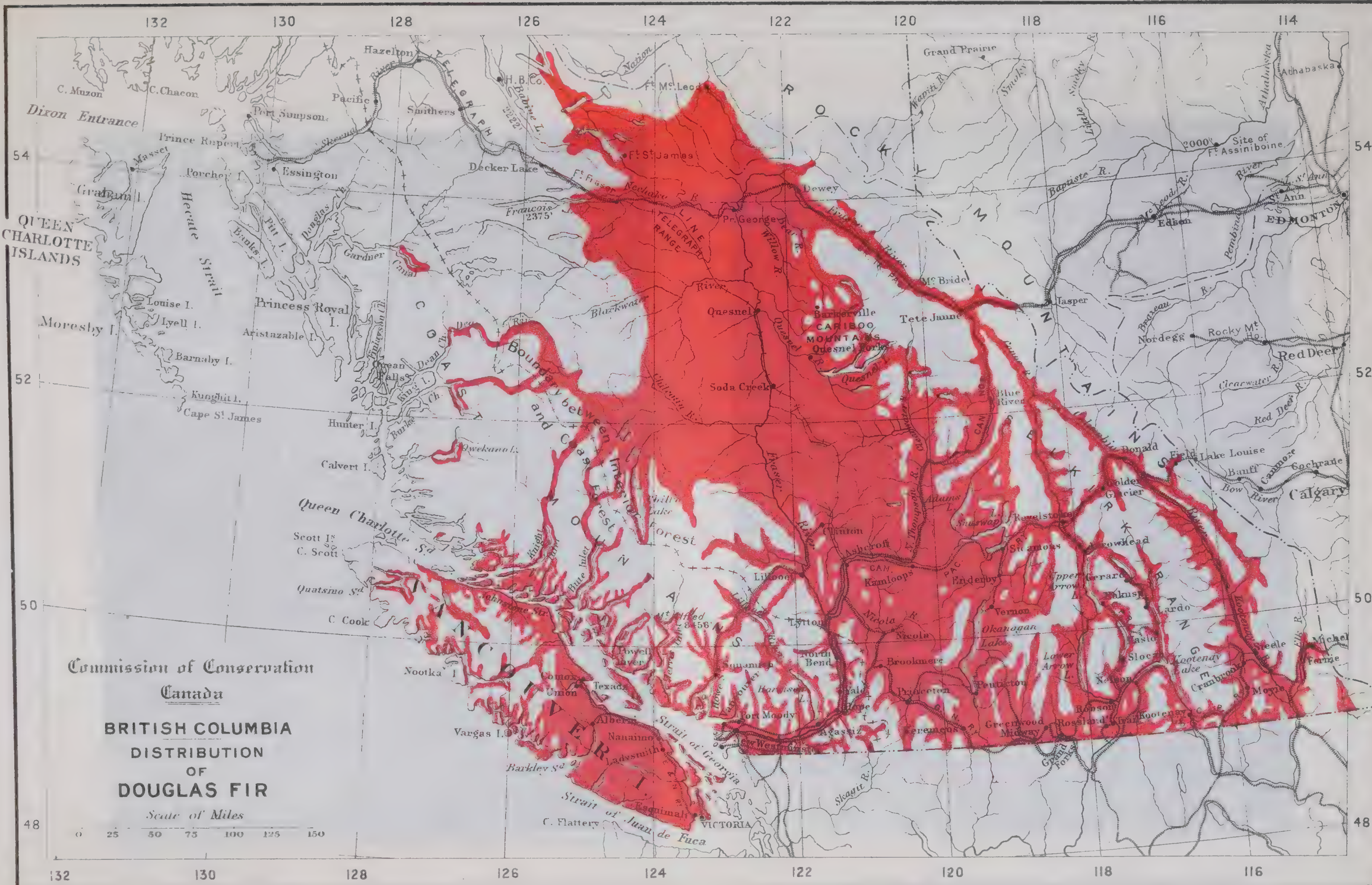
Douglas fir is the best known and, undoubtedly, the most important forest tree in the province. The export trade, except that to the United States, is almost entirely confined to this wood. In 1915, 67·7 per cent* of the lumber manufactured and 42 per cent† of the total amount of timber cut in the province was Douglas fir. In 1916, 44·1 per cent of the total cut was Douglas fir. Though confined to the southern half of the province, it forms approximately 22 per cent of the total stand of saw material. On the coast it comprises nearly 30 per cent, and in the interior a little over 9 per cent. In all, there is estimated to be 76,000 million feet standing in the province.

Douglas fir reaches its best development in the region directly tributary to the salt water, between the mouth of the Columbia river and Seymour narrows. In British Columbia, it occurs on the coast as far north as the head of Vancouver island; and, though not found close to the northern coast, it reappears near the upper ends of the fiords as far north as Gardner canal. It is not reported at Ootsa lake, Eutsuk lake or the headwaters of Dean river, but is found along the Grand Trunk Pacific railway to the east of Burns lake. It extends as far north as the southern end of Tacla lake and to Fort McLeod, and crosses the Rocky mountains to the foothills in Alberta.

It thrives best on well-drained soils, where the annual precipitation is between 50 and 60 inches, and where the climate is moderate and not subject to extremes. It grows in the interior where the extremes in temperature are very great and the water supply scant; but, under these conditions, it is much smaller, and the wood is not of such good quality. It is a light-demanding species and grows best in even-aged stands, where, owing to its rapid growth, it soon becomes the predominant species. It reproduces readily when the seeds reach mineral soil and sufficient light is available; but it is at a disadvantage, as compared with hemlock and cedar, in the virgin forests, where the soil is covered with vegetable mould and it is shaded by the large trees. The seeds of fir have been found to retain their vitality for several years, and clear cutting and immediate slash burning are usually followed by good fir reproduction.

With the exception of the giant sequoias and redwoods of California, the Douglas fir is the largest tree on the Pacific coast. It ordinarily attains a height of from 175 to 200 feet, and a diameter of from 3 to 6 feet. Not infrequently,

* *Forest Products of Canada, 1915, Dominion Forestry Branch Bulletin, No. 58A.*
† *Report of the British Columbia Forest Branch, 1915.*



Accompanying report on "Forests in British Columbia" by H.N. Whitford, Ph.D., and Roland D. Craig, F.E.

Base map from plate of Map of Dominion of Canada, Dept. of Interior

Photo. by Shields Lumber Co.

RED CEDAR, HEMLOCK AND DOUGLAS FIR, NEAR CHILLIWACK

DOUGLAS FIR, NEAR OYSTER RIVER, VANCOUVER ISLAND

trees up to 250 feet in height and from 6 to 9 feet in diameter are seen. Owing to its intolerance of shade, the lower branches soon die and drop off, leaving one-half to two-thirds of the bole clear and a large percentage of the wood free of knots.

The appearance of the bark of the fir varies so greatly in appearance that, from this feature alone, it would be difficult to recognize two specimens of extreme types as belonging to the same species. On young trees, until they reach 12 to 16 inches in diameter, the bark is smooth, ashy-brown, with lighter patches and resin blisters. It resembles balsam so closely that it is sometimes mistaken for it. On large trees the bark is ordinarily 5 to 10 inches thick at the base of the trunk, sometimes even thicker. Typically the bark is of a dark-brown colour on the outside and reddish-brown when cut into. Ordinarily it is deeply furrowed. In old age, on good sites, the furrows are not so pronounced and the surface breaks up into flaky scales. The bark makes excellent fuel, burning readily but more slowly than the wood.

The foliage, when mature, is dark-green, which affords a contrast to the lighter yellowish-green of the cedar. The leaves persist for seven or eight years; they are usually about an inch to an inch and one-half long, flat, soft and, as a rule, blunt pointed.

The cones are reddish-brown and from 2 to 3 inches long. The most conspicuous feature is the three-pointed bracts which protrude from under the cone scales. The cones ripen in August and September and, while on the tree, open to shed their seeds.

The rate of growth of the fir varies greatly with the environment. On the coast it has reached 80 feet in height and 13 to 14 inches in diameter in 50 years.* In the drier regions of the interior it may only attain 14 feet in height and 3 to 4 inches in diameter in the same time. Dr. C. A. Schenck reports having measured a forty-year-old stand of fir in Washington, which carried 40 M.b.f. per acre, an average of 1,000 board feet per acre per annum.

Douglas fir has been successfully planted in Great Britain and Continental Europe. Where the climate is not severe care should be exercised to secure stock of the coast type. In eastern Canada and the north-eastern states the interior type will be found more hardy.

In the virgin forests on the coast, where fir predominates, the stands usually run from 20,000 b.f. to 50,000 b.f. per acre, though frequently, on the better sites, the yield exceeds 100,000 b.f. per acre; one instance being recorded where 5,000,000 b.f. was cut from 10 acres. Single mature trees ordinarily contain from 2,000 to 5,000 b.f., but, sometimes, exceed 10,000 b.f. In the mountains, the fir stands usually run from 5,000 to 15,000 b.f. per acre, though in some of the more moist valleys stands are found almost equal to those on the coast. In the interior dry belt the individual fir trees usually contain from 500 to 2,000 b.f.

Douglas fir is, perhaps, the healthiest tree in British Columbia. It does not suffer from insect pests or fungus diseases to nearly the same extent as do the hemlock and cedar. The logs are remarkably sound, even from very old

* Figures for the State of Washington, from *U.S. Forest Service Bulletin, No. 33.*

trees. Owing to its intolerance of shade, however, the tendency in the virgin forests is for the fir to be replaced by hemlock and cedar.

The production of Douglas fir lumber has increased rapidly in the last fifteen years. In 1913 more Douglas fir timber was cut in both Canada and the United States than any other single species. Though, owing to the effects of the war, it has fallen behind white pine in Canada for the last two years, it may be safely predicted that it will quickly regain its place as the premier construction wood of Canada. The tests made by the U.S. Forest Service* show that Douglas fir is the strongest wood, for its weight, in the United States. The large sizes which can be cut from these huge trees render it especially valuable for ship-building and heavy construction.†

Its green weight is about 3,300 pounds per 1,000 b. f.; but, when the lumber is kiln dried, as it usually is before shipping by rail, it weighs about 2,500 pounds per 1,000 b.f. The sapwood is usually not over two inches wide. The heartwood varies in colour from reddish to yellowish. The wood from the centre of old trees, from second growth, or from trees growing under unfavourable climatic conditions, is likely to be coarse-grained and reddish in colour. On the coast, however, a large proportion of the wood is clear, fine-grained and light-yellow in colour.

In the building trades it is a most valuable wood, being used for beams, joists, heavy flooring in mill construction, siding and for all general purposes. Owing to its hardness it is used extensively for flooring, for which purpose it is cut edge-grained. For interior finish, it is recognized as perhaps the most beautiful of our Canadian woods. On account of the distinct alternating rings of spring and summer wood, it presents, when cut tangentially, a most attractive grain, rivalling quarter-sawn oak in beauty. Douglas fir hardens with age, and, when polished, has a mar-resisting surface which renders it especially useful and attractive for doors, panels, beams and other interior woodwork. It takes stain well, and can, therefore, be given a variety of finishes.

Western Red Cedar—(*Thuya plicata*—Don)

The botanical name, *Thuya gigantea*, has also been applied to this species, on account of its size. Among the common names applied to it are giant arborvitæ, giant cedar, canoe cedar, shinglewood, Pacific red cedar and Lobb's arborvitæ (in cultivation in England). Since it is the only true cedar in British Columbia, it is locally known simply as either cedar or red cedar. The latter name is used to distinguish it from yellow cypress, which is often called yellow cedar.

The cedar is confined chiefly to wet or constantly moist situations, and where precipitation is abundant. Its range extends, along the Pacific coast, from south-eastern Alaska to northern California. In British Columbia it is found on Vancouver island, Queen Charlotte islands and throughout the

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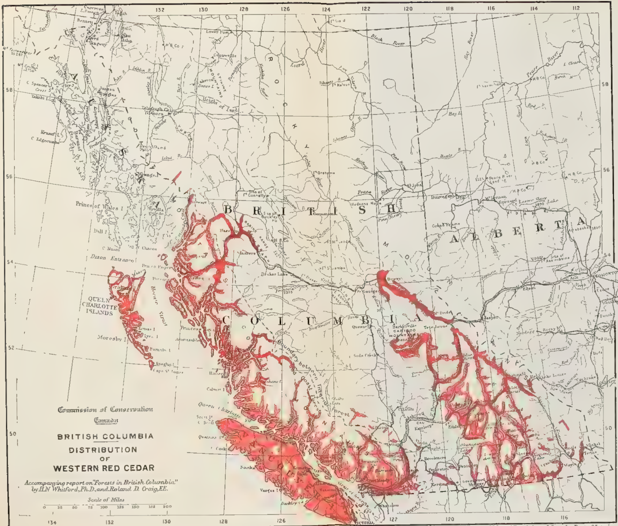
* *Tests of Structural Timbers, U.S. Forest Service Bulletin, No. 108.*

† The strength of Douglas fir, as compared with other woods, native and imported, which compete with it in Canada, is shown in Tables 4 and 5 in *Canadian Woods for Structural Timbers, Bulletin, No. 59,* Dominion Forestry Branch.



Base map from plate of Map of Dominion of Canada, Dept. of Interior

western slope of the Coast mountains, as far north as the head of Portland canal, and extending up the valley of the Skeena river to a short distance beyond Hazelton. It is absent from the central and northern portions of the Interior plateau, but is found in suitable sites in the south-eastern portion of the province, as far west as Similkameen river, Okanagan, Adams and Quesnel lakes and Bowron river. The northern limit of cedar is in the valley of the Fraser river; it is not known to occur on the eastern slope of the Rocky mountains. Cedar reaches its best development in the southern coastal region bordering on the strait of Georgia, though on the islands and mainlands in the vicinity of Queen Charlotte sound, it is the predominating species; and, is therefore, of greater relative importance in the latter locality.

Western red cedar has enhanced greatly in commercial importance in the last few years, and, since British Columbia possesses such a vast store—about 78 billion feet—it forms a most valuable part of the forest wealth of the province. The estimates secured in this investigation show that there is more cedar than any other species standing in British Columbia. It forms over 22 per cent of the total stand. On the coast 28 per cent is cedar and, in the interior, slightly over 13 per cent. The cedars, as a class, possess exceptional durability when exposed to the weather. On this account, they are suitable for a number of purposes for which no other American wood, with the possible exception of cypress, can be satisfactorily used. The available supply of red cedar is fast becoming depleted in the United States and eastern Canada, with the result that the demand for British Columbia red cedar is increasing, and is likely to continue to increase, as time goes on. The cut of cedar in British Columbia was 354,702 M.b.f. in 1915 and 385,096 M.b.f. in 1916. These amounts represented 34·9 per cent and 30·1 per cent, respectively, of the total cut. The manufacture of shingles accounts for from 50 to 70 per cent of its total cut.

'Giant cedar' is a name well merited by this tree, for it frequently attains a height of over 175 feet, and a basal diameter of over 10 feet. The ordinary size, which is at present being cut on the coast, is from 3 to 8 feet in diameter, and from 100 to 150 feet in height. Unlike the fir, its trunk quickly tapers, so that the diameter at the upper end of the first 32-foot log seldom exceeds three feet. The lumber content of a cedar tree is, therefore, from one-third to one-fourth less than a fir of the same diameter at breast height. In the young trees the taper is not so pronounced, since they usually grow in fairly dense stands, forming excellent long slender poles. The older trees are usually hollow in the centre. This defect is particularly common in the mountain region, and makes it very difficult to estimate the merchantable contents of standing cedar.

Red cedar is very tolerant of shade, and will live for many years overshadowed by other trees, growing so slowly that the use of a strong magnifying glass is necessary to distinguish the annual rings. However, given light and favourable soil conditions, it grows rapidly, frequently adding an average of one-half inch per year to the diameter over a number of years. Second growth

cedar, near Vancouver, has been recorded as producing wood having less than three annual rings to the inch.*

Grown in the open, it produces a beautiful conical tree, branched to the ground, but in dense stands usually about half of the bole is clear. Being shade-enduring, it does not shed its lower limbs so well as the fir, and it seems to require the association of and competition with the fir to enable it to attain its best development in form and quality.

The bark of the cedar is bright cinnamon-red in colour; but, on the outside, it usually becomes grayish-brown, from long exposure to the weather. It is seldom much over an inch thick, even on old trees. The surface of the bark is broken by shallow seams, separating the bark into long, narrow strips, which extend irregularly, but continuously, the length of the trunk. The inner bark is tough and fibrous, and is used by the Indians to make baskets and matting. The foliage is of a yellowish-green colour, which makes it conspicuous when mixed with fir, hemlock or spruce.

The cones, which are only about one-half inch long, ripen in August, and the little winged seeds are often carried long distances by the wind. The seeds soon lose their ability to germinate if they do not fall on suitable ground. Seedlings grow best on moist beds of moss, decaying logs, or other vegetable matter. On exposed mineral soil, such as results from severe forest fires, cedar does not reproduce well. It seldom grows in pure stands, but is usually associated with Douglas fir, hemlock, balsam or spruce. In one exceptional area of a few acres the writer has estimated the stand of cedar to exceed 150 M.b.f. per acre; but, on ordinary good sites, where it is predominant, it yields, as a rule, between 20 and 60 M.b.f. per acre.

The wood is light, soft and not strong. It varies from a dark reddish-brown to a lighter straw colour. The sapwood is usually not more than two inches wide and is very light in colour. The cedar is usually very straight-grained, and it splits so readily that it is used largely by the Indians and woodsmen to make split boards or shingles, called 'shakes', with which to construct their houses. The Indians also make their famous dug-out canoes of cedar. War canoes, up to 60 feet in length with 8-feet beam, are hewn out of single trees.

Cedar is not strong enough to make good dimension lumber; and, though it can be given a beautiful finish and has an attractive grain, it is too soft for inside finish where subject to much wear. Owing to its weather-resisting qualities, and its freedom from warping, shrinking, checking or splitting, it is essentially an outside wood. For siding and exterior finish it is unsurpassed, and it is also satisfactory for sash and door stock. It will take and hold paint better than almost any other wood. Its light weight when dry gives it a considerable advantage over the heavier woods in the matter of freight rates and enables it to be shipped by rail to the eastern markets.

There is perhaps no other British Columbia wood in which quality makes such a difference in value as in cedar. Not being suitable for dimension purposes, the lumber is required almost exclusively for exposed woodwork, where clear, sound material is required. Cedar logs of the poorer quality are

* 'British Columbia Red Cedar'—Aird Flavelle, *Proceedings of the B.C. Forest Club, 1915.*

to a large extent used in the manufacture of shingles, where defects can more readily be avoided. British Columbia red cedar shingles have won a reputation for quality which is continent-wide, and, as a result, the market for them is steadily increasing. In this connection if is significant that British Columbia shingles sell in the United States at a premium of from 10 cents to 50 cents, averaging 25 to 30 cents per thousand, over the current prices of American shingles of similar dimensions. The large sizes, straight grain and freedom from knots, coupled with its resistance to decay, are most valuable qualities for shingle manufacture. Many examples of the long life of red cedar shingles have been recorded. The Indian potlatch houses were nearly all made of cedar shakes. On San Juan island, the roof of a house, built in 1856, is still intact. Near Tacoma, Wash., the roof of a house which was laid with sawed red cedar shingles over 30 years ago, is still in perfect condition.

The resistance to decay is demonstrated in the woods. Old cedar windfalls, that fell centuries before Columbus discovered America, are still sound, except for the sapwood, though another generation of forests has grown to maturity on top of them. Though, on account of the thinness of the bark, it is very easily killed by fire, cedar sustains perhaps less damage, commercially, from fire than any other coast species. This is due to the fact that the wood in the fire-killed trees, whether standing or down, remains sound for many years.

Cedar lumber or shingles should not be kiln-dried too quickly, since the high temperatures incident to quick drying will break down the structure of the wood. It is claimed that, except for the saving effected in freight charges, it would be better not to kiln-dry the shingles at all. A considerable proportion of the shingles have, up to the present, been cut from 'bolts' 52 inches long and about a foot in diameter. These bolts are, to a large extent, secured from material which has been left standing or on the ground after logging. The tall stumps cut by the loggers are frequently used to advantage for this purpose. In some cases, the logs are split up into bolts in the woods, but unless this method is necessitated by difficulties of logging or transportation, it is a wasteful method of exploitation. The shingle mills, are, however, getting their material in increasing amounts from logs, from which shingles can be cut with less waste than from bolts.

The resistance of the wood to decay makes cedar particularly desirable for posts and poles. Over 2,500,000 lineal feet of poles and piling of various species were cut in the province in 1916. It may be estimated that at least 2,000,000 lineal feet of this was of cedar, about 90 per cent of which was exported.

YELLOW CYPRESS—(*Chamæcyparis nootkatensis* [LAMB.]—Spach.)

This species is most frequently called yellow cedar in British Columbia. It is known also as Alaska cedar, Alaska cypress, Sitka cypress or Nootka Sound cypress (in cultivation, England). It is confined to the coastal region, from Alaska to northern Oregon. In British Columbia, it occurs as far north as Stikine river. In the vicinity of the strait of Georgia it is seldom found

at altitudes below 2,000 feet, and extends up to 5,000 feet. Towards the north it gradually descends until it reaches tide-water at Knight inlet. It is abundant all along the northern coast, especially on exposed and unpropitious sites.

In general appearance it resembles red cedar very much; but the bark is somewhat more ashy in colour, and the flat, blue-green sprays of foliage are noticeably harsh and prickly to the touch, unlike the smooth foliage of red cedar. The cones are spherical, dark red-brown and about one-half inch in diameter. The cone scales are shield-like, with a short spine in the centre of each. The trunk usually tapers very rapidly, and the base is often conspicuously fluted. The wood is bright sulphur-yellow in colour, even-grained and has a decidedly unpleasant odour, not at all like cedar. It is perhaps the heaviest and most durable coniferous wood in the province. It is easily worked, and takes a beautiful satin-finish, which renders it especially useful for interior wood-work and cabinet work. It is practically unaffected by changes in moisture, and is less liable to shrink, warp or check than any other wood grown in the province. For this reason it is in great demand for boat-building material, and is particularly satisfactory as sash and door stock. It is said to be immune against the teredo. Clear yellow cypress is perhaps the highest priced lumber produced in the province, as high as $100 per M. having been paid for it by local boat builders. The lower grades of yellow cypress, however, are difficult to dispose of.

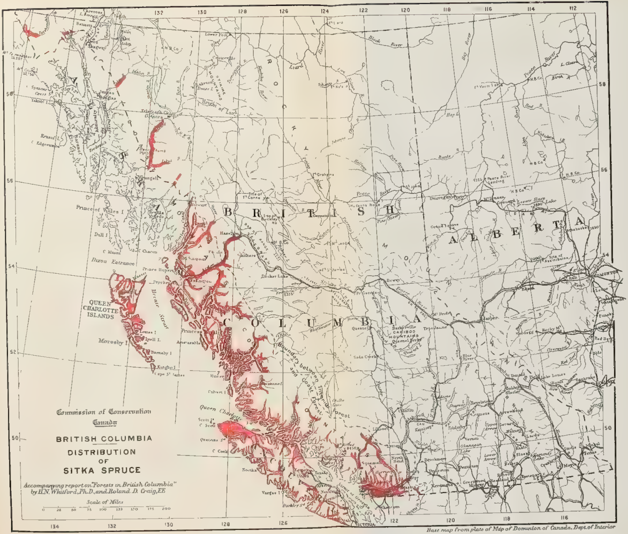
It is unfortunate that the supply of good yellow cypress is so limited, and that it grows, as a rule, in situations which, at present, are considered inaccessible. The best quality is developed in the southern coastal region; in the north it is usually a scrubby tree, from which a comparatively small amount of good lumber can be cut. There is estimated to be approximately four billion feet in the province, but the cut in 1916 was only 75 M.b.f., and, in 1915, only 30 M.b.f.

SPRUCE

There are four species of spruce in British Columbia—Sitka spruce, Engelmann spruce, white spruce and black spruce. There is estimated to be over 73 billion feet of spruce in the province, which represents nearly 21 per cent of the total stand. On the coast, there is 14 billion feet, which is practically all Sitka spruce; in the interior there is approximately 59 billion feet, all but about 3 billion feet of which is Engelmann spruce, and the remainder white and black spruce.

In recording the cuts, no distinction has been made in the species; but about 80 per cent of the 85,329 M. b.f. cut in 1916 was cut on the coast, and was, therefore, Sitka spruce. Spruce comprises less than 7 per cent of the total timber cut of the province.

The spruces may be distinguished from fir, balsam or hemlock by the fact that their leaves are stiff, often very keenly pointed and are, roughly, four-angled. They are arranged spirally on the twigs, but are twisted so that they appear to stand up mainly from the top of the branch. The cones are thin scaled and pendent.


Commission of Conservation
Canada
BRITISH COLUMBIA
DISTRIBUTION
OF
SITKA SPRUCE
Accompanying report on "Forests in British Columbia" by H.N. Whitford, Ph.D., and Roland D. Craig, F.E.
Scale of Miles
BRITISH COLUMBIA
ALBERTA
QUEEN CHARLOTTE ISLANDS
Moresby I.
Prince of Wales I.
Dixon Entrance
Hecate Strait
Queen Charlotte Sd
Prince Rupert
Wrangell
Victoria
Boundary between Interior and Coast Forest
Base map from plate of Map of Dominion of Canada, Dept. of Interior

The bark is thin, dark purplish-brown, and becomes scaly while the trees are comparatively small. The different species are sometimes difficult to distinguish, since their characteristics vary considerably.

The wood is white, soft, light and easily workable, possessing a maximum of strength for its weight. It is useful for light construction and interior finish, where the wear is not too great. The war has created a demand for clear spruce in the manufacture of airplanes. Spruce is considered the best wood in Canada for the manufacture of pulp.

Sitka Spruce—(*Picea sitchensis* [Bong.]—Trautvetter and Mayer)

This species is also known as tideland spruce, Menzies spruce and western spruce. It is confined to the Pacific coast, from Alaska to northern California, seldom extending more than 50 miles back from salt water. Though it is reported to have an altitudinal range of from sea level to 5,000 feet,* it is seldom found in commercial sizes above 1,000 feet elevation in British Columbia, and is usually confined to the valley bottoms. It is generally distributed throughout the western slope of the Coast mountains and on Vancouver and Queen Charlotte islands. It extends a short distance up Taku river and up the Stikine nearly to Grand rapids. In the Nass valley it is found only in the lower portion, from Cranberry river down. It ascends the Skeena almost to Hazelton; and, in the Fraser drainage, it is reported at the summit of Coquihalla pass.

Though Sitka spruce is one of the most valuable trees in the province, it is, unfortunately, not very abundant. Less than seven per cent of the merchantable stand on the coast is Sitka spruce, most of which is to be found in the northern coastal region, extending from about the head of Vancouver island to Portland canal, and including Queen Charlotte islands.

Sitka spruce is one of the largest trees on the coast, attaining a diameter of from 8 to 12 feet and a height of from 160 to 180 feet. Ordinarily it is from three to six feet in diameter, and 100 to 125 feet high. When grown in fairly dense stands the trunk is usually clear for from 40 to 80 feet, and it tapers very little till the branches are reached. Single trees contain from 8,000 to 10,000 b.f., and occasionally as much as 15,000 b.f. It seldom occurs in pure stands, but, in mixture with hemlock and balsam or with cottonwood, it frequently runs from 40 to 60 M. per acre.

The leaves of the Sitka spruce are more flattened than in the other species, and are of a dark bluish-green colour. The cones, which usually hang from the tips of the branchlets, vary from 2 to 4 inches in length, usually about 3 inches. The cone scales are thin and papery with irregular edges.

It is a prolific seeder, and the seeds usually have a high rate of germination and vitality. Reproduction is secured most readily in moist soils rich in vegetable matter, and the seedlings will stand very dense shade. Later, however, the spruce is not so shade-enduring as either the western hemlock or western red cedar. It grows rapidly under favourable conditions, and

* *Forest Trees of the Pacific Slope*—Sudworth.

usually soon over-tops the hemlock. Unless grown in fairly dense stands, it does not shed its lower limbs very readily and, for this reason, Sitka spruce, especially from the more exposed situations of the northern coast, does not yield such a high percentage of clear lumber as some of the other coastal species. Usually, however, one side of the trunk is clear, and, owing to the large sizes, a very superior grade of lumber can be cut. The wood is lighter and softer than fir, and enjoys a preference in some parts of the prairie market where the trade is accustomed to the use of spruce. On account of its lightness, strength and evenness of grain it is used for sounding boards for musical instruments. The demand for spruce lumber usually greatly exceeds the supply. The pulp industry provides a ready market for spruce since it is considered the best wood for the manufacture of paper. An enormous demand has developed for clear lumber of this species for airplane construction, for the use of the Allies.

Engelmann Spruce—(*Picea Engelmanni*—Engelmann)

This is a western species, which occurs throughout the interior montane region from Arizona to northern British Columbia. It does not occur on the western slope of the Coast mountains nor, so far as is known, in the area drained by the Stikine and Liard rivers. On the eastern slope of the Rockies it extends to the edge of the foothills. In the southern portion of the inte ior, it forms an important part of the forest at altitudes between 3,500 and 5,000 feet. In the northern portion of its range it occurs between 1,000 and 4,000 feet elevation.

The most prominent features which distinguish it from Sitka spruce are that the leaves are thicker and more decidedly four-sided, and the cone scales are shorter and broader. This species usually has a narrowly pyramidal crown, and it does not grow to such large sizes as the Sitka spruce, the trees usually being from 18 to 36 inches in diameter and from 80 to 100 feet high. As a rule, it occurs in mixed stands, with alpine fir or lodgepole pine, but frequently it is found in almost pure stands. In dense stands it produces long, clear trunks, with very little taper. It is quite tolerant of shade, but responds quickly by increased growth to the influence of light.

From the standpoint of supply, it is the most important species in the interior of the province, comprising approximately 40 per cent of the stand. Of the 59 billion feet of spruce in the interior, 56 billion feet are of this species. It does not produce such heavy stands as the coast spruce, 10,000 b.f. to 25,000 b.f. per acre being fairly good yields.

The spruce resources of the interior have, as yet, been exploited to only a very limited extent. In 1916, only about 15 million b.f. of spruce was cut in this region, and, no doubt, most of this was Engelmann spruce. With the improvement of transportation facilities, these spruce forests are becoming accessible, and will undoubtedly, in the near future, play a more important part in the lumber and pulp production of the province.

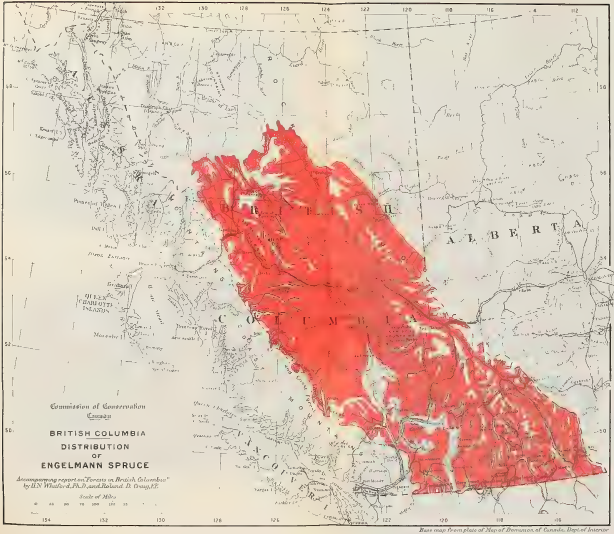


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Photo by Shields Lumber Co.

RED CEDAR, ON SPUZZUM CREEK, FRASER RIVER

Photo. by Shields Lumber Co.

TYPICAL COAST FOREST WITH RED CEDAR PREDOMINATING

White Spruce—(*Picea canadensis* [Mill]—B., S. & P.)

The white spruce is one of the most widely distributed tree species in America. Its range in Canada extends from Nova Scotia to Yukon, and, except for the southern and western portions of British Columbia, is usually found wherever there are forests. In British Columbia its southern limit of distribution includes the Stikine, upper Nass and Skeena rivers, Babine lake, Nechako river, Prince George and the Fraser rivers. There is estimated to be between 2 and 3 billion feet of white spruce in the province.

It is distinguishable from the preceding spruces by its stiffer and usually shorter leaves, and its smaller and narrower cones, the scales of which are short and broad and with entire edges.

In similar sites, white spruce grows to about the same size as Engelmann spruce; but, in its northern habitat, naturally it is smaller. It is quite shade-enduring, and, unless grown in dense stands, does not clean its trunk well.

Black Spruce—(*Picea mariana* [Mill.]—B., S. & P.)

Like the white spruce, this species is general across Canada. Its southern limit in British Columbia coincides closely with that of white spruce, but it is not found so far west in the northern portion of its range. From the information available, its western limit is between Teslin and Atlin lakes and to the east of Telegraph Creek, on Stikine river.

In British Columbia it is a stunted tree, seldom over 25 feet high, and is found usually in cold, swampy places. In the northern mining districts, where wood of any kind is scarce, it has some value for local use, but it cannot be considered an important forest tree.

Western Hemlock—(*Tsuga heterophylla* [Raf]—Sargent)

On account of the somewhat unenviable reputation of eastern hemlock lumber, attempts have been made to give the western species a distinct name, and Alaska pine is the most prevalent of these pseudonyms. Since the superior quality of western hemlock has become generally recognized, and, since even the eastern species is no longer scorned, the need for an alias is no longer felt. The name *Tsuga mertensiana*, which rightly belongs to the mountain hemlock, has been applied to this species.

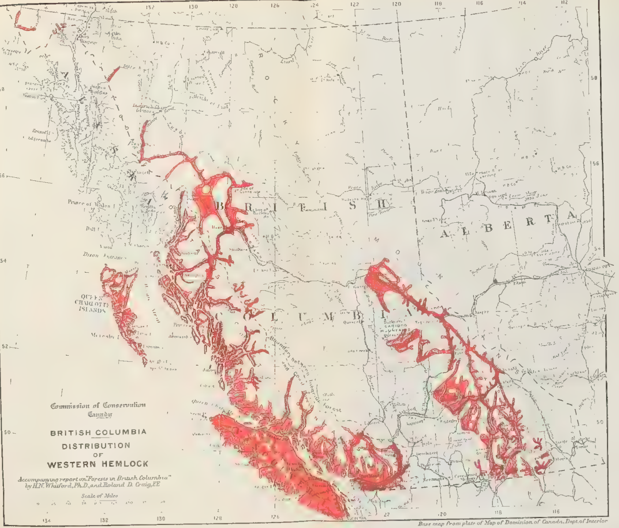
The western hemlock is a product of the damp climate of the Pacific northwest. With abundant atmospheric and soil moisture, it thrives on poor, thin soils and on any exposure, but best on deep, porous, moist soils. On the coast, its range extends from the fog belt in northern California to Alaska. In British Columbia, it is found distributed generally west of the Coast mountains, up to altitudes of 4,000 feet. It extends up the Taku river a short distance, and up Stikine river to Grand rapids. It is found throughout the main valley of the Nass river, and to beyond Hazelton on Skeena. Hemlock is absent entirely from the interior plateau, but reappears in the Columbia and Rocky Mountain systems, where it occurs in the following regions: Arrow lakes, Kootenay, Mabel and Shuswap lakes, 'Big Bend' of the Columbia,

Canoe river, Adams lake, upper North Thompson and Clearwater rivers, Quesnel lake, Bowron river, and in the valley of the Fraser above Willow river. It does not cross the Rockies into Alberta, and is not reported in the valley of Kootenay river. In the Selkirk mountains it ranges up to 5,000 feet altitude.

Western hemlock is one of the most important species in British Columbia, in regard to both production and available supply. There is estimated to be 52 billion feet on the coast and 12 billion feet in the interior. On the coast it forms about 24 per cent of the merchantable stand, in the interior about 9 per cent, and a little over 18 per cent of the total stand of the province. The establishment of pulp mills on the coast has given great impetus to the exploitation of hemlock. The cut of hemlock was 79,392 M. in 1915, and 101,315 M. in 1916, which represented 7·8 and 7·9 per cent, respectively, of the total cut in the province. Of this cut, about one-third is manufactured into lumber and the remainder is used by the pulp-mills.

Western hemlock is, perhaps, the most shade-enduring species on the Pacific coast. It reproduces abundantly in dense shade, and the seedlings struggle along for many years under the main stand, in a suppressed, but healthy condition. Hemlock is seldom found in pure stands, but is usually mixed with either fir, cedar or spruce, where it occupies a subordinate place in the stand; or with balsam and cedar, where it is usually predominant. The hemlock grows to a height of from 125 to 160 feet and a diameter of from 2 to 5 feet. As a rule, however, it does not exceed 3 feet in diameter. When grown in a fairly dense stand, it produces a long, clean bole, with very little taper, and from 50 to 70 feet clear of limbs. The bark is usually from 1¼ to 1½ inches thick, hard and deeply furrowed. It varies in colour from a russet-brown to a light gray. There are two varieties, distinguished as 'black' and 'white' by the lumbermen. The white-barked hemlock is usually more healthy and free from defects. The foliage of the hemlock is of a lighter green than the fir, but not so yellowish as the cedar. The leaves are flat, grooved above, have rounded ends and distinct threadlike stems, which, except on the terminal shoots, bend so that the leaves lie in a single plane. The cones, which hang at the ends of the branchlets, are usually about ¾ to 1 inch long, and ripen in the latter part of August. The seeds have comparatively large wings, which enable them to travel some distance. They germinate most readily on damp moss or decaying vegetable mold, and, as long as moisture is available, the seedings do not require to reach mineral soil. Young trees are frequently seen growing on the tops of old stumps 10 feet or more high. The roots finally grow down through the bark of the stump to the ground, and when the stump rots away the hemlock is left standing on the leg-like roots.

The ability of this species to withstand shade frequently results in the establishment of hemlock reproduction, to the almost complete exclusion of the other species. Under undisturbed forest conditions hemlock grows very slowly, trees 15 to 18 inches in diameter frequently being upwards of 200 years old. With light and suitable soil conditions, however, it grows


Commission of Conservation
Canada
BRITISH COLUMBIA
DISTRIBUTION
OF
WESTERN HEMLOCK
Accompanying report on "Forests in British Columbia"
by H.N. Whitford, Ph.D., and Roland D. Craig, F.E.
Scale of Miles
Base map from plate of Map of Dominion of Canada, Dept. of Interior
BRITISH
COLUMBIA
ALBERTA
QUEEN CHARLOTTE ISLANDS
Prince of Wales I.
Dixon Entrance
CARIBOO MOUNTAINS
Boundary between Interior and Coast Forest
Peace River

rapidly; an annual diameter growth of from one-half to three-quarters of an inch being sometimes secured. Hemlock does not produce very heavy yields; where it forms the principal part of the stand, it seldom exceeds 50 M.b.f. per acre, usually about 20 M.b.f. Single trees seldom contain over 3,500 b.f., averaging perhaps 1,000 b.f.

Hemlock is particularly susceptible to fungus diseases and insect pests. It is undoubtedly the most unhealthy species in the province. This may be due largely to the thinness of the bark, the usual suppression in early life, or the absence of protecting oils or resin in the wood. The most prevalent fungus diseases are conk (*Trametes pini* and *Echinodontium tinctorium*) and ground rot (*Polyporus Schweinitzii*). It is also subject to attacks of defoliating caterpillars.

In spite of the early prejudice against the use of hemlock for lumber, it is rapidly becoming recognized as one of the finest Canadian woods for general construction or finishing purposes. It is very light coloured, almost white, and the grain, though not so distinct as that of fir, is straight and very attractive. It is hard and strong, takes an excellent stain and polish, and is entirely free from pitch. Though not so strong as fir, it is suitable for all but the heaviest construction work. It does not split so readily as fir and holds the nails very much better. For use in contact with the soil it does not give such long service as fir; but, after preservative treatment, it is said to be as good, if not superior, for such purposes as railway ties. It is useful for underwater purposes, such as piling. For flooring, panelling, doors and other interior woodwork it almost equals fir. Though, when drying, more inclined to warp than fir, it is much superior to the eastern hemlock in this regard.

As a pulpwood, it is perhaps the most important species in the province. It can be successfully reduced by either the mechanical or sulphite processes, but the soda process does not appear to be suitable for this wood. By the sulphite process an average of about 1,050 pounds of air-dry pulp can be produced from a cord of wood, which is slightly more than can be secured from Sitka spruce or balsam.

Mountain Hemlock—(*Tsuga Mertensiana* [Bong.]—Sargent)

This species has also been called *Tsuga Pattoniana* (Jeffr.) Engelm. by botanists. It has also several common names, such as black hemlock, Patton's spruce, alpine spruce and hemlock spruce. It occurs from Alaska southward to the high sierras of California, and to northern Idaho and Montana. In British Columbia it is found throughout the coastal belt, usually at altitudes between 2,500 and 6,000 feet in the southern portion, but descending nearly to sea level in the more exposed and wetter situations in the north. It is also found in the mountains of the Columbia and Skeena systems.

It is a small, scrubby species, with little or no commercial value. It is, however, the most ornamental species of hemlock, the foliage being darker and fuller than that of the other hemlocks. It is most easily distinguished

from western hemlock by the more bristly appearance of the foliage owing to the leaves sticking out in all directions from the branches, and their rounded and plump appearance. The cones are much larger on this species, being from 1½ to 2½ inches long.

BALSAM

There are three species of Abies occurring in British Columbia. *A. grandis, A. amabilis* and *A. lasiocarpa.* They are not, as a rule, distinguished by lumbermen, but are known collectively as balsam or larch, sometimes as balsam fir, white fir or silver fir. Though they are true firs, it is considered advisable to refer to them as balsam, to avoid confusion with Douglas fir. The name 'larch' is incongruous, however, since these trees have no resemblance to the true larch or tamarack.

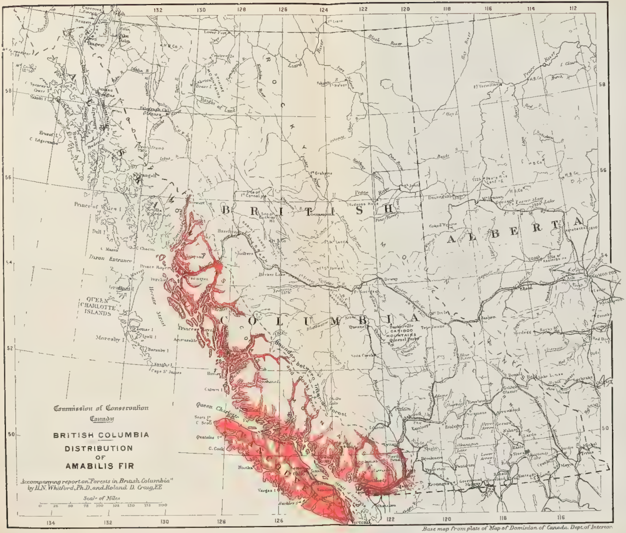
In appearance and wood qualities the different species of *Abies* are very similar. They all have characteristic conical, often spire-like, dense crowns. The leaves on the lower branches are flat, flexible, not sharp-pointed, and extend horizontally from the branchlets. On the upper branches and leader they are stouter, crowded and sometimes sharp-pointed. The foliage is dark green and shiny. The cones are from 2 to 5½ inches long, stand erect on the branches, and the scales fall away from the central spike-like axes to liberate the seeds. The trunks are, as a rule, tall, very straight, and evenly and gradually tapered. The bark, when young, is smooth, ashy-brown with chalky areas and it is marked conspicuously by blister-like resin pockets. With age, the bark becomes furrowed and darker in colour. The wood varies in colour from light yellow to almost white. It is soft and not strong. The better grades resemble spruce. As lumber, it is used chiefly for light construction or box manufacture. Its chief value, however, is as pulpwood, for which purpose it is one of the most valuable of the western trees.

There is estimated to be 33 billion feet of balsam in the province, of which 19 billion is on the coast and 14 billion in the interior; comprising about 10 per cent of the total stand. In 1916, only 21,406 M.b.f. of balsam was cut in the province, this being less than 2 per cent of the total cut. Of this, 20,663 M.b.f. was cut on the coast and was used chiefly for pulp.

Lowland Fir—(*Abies grandis*—Lindley)

This species is known also as grand fir or white fir. It occupies moist situations, such as alluvial stream bottoms and the lower gentle mountain slopes, depressions and gulches, and is found along the coast from northern California to southern British Columbia. It occurs on Vancouver island and the adjacent mainland, west of the summit of the coast mountains, and reappears in the southeastern portion of the province in the regions draining into Arrow lakes, Sugar, Mabel and Kootenay lakes and Moyie river, and again on Elk river and the headwaters of Bull and Flathead rivers.

The most characteristic features of this species are that the lower leaves are distinctly notched at their ends and the cones are of a light yellow-green colour, 2½ to 4¼ inches long by 1 inch to 1⅛ inches in diameter.



Base map from plate of Map of Dominion of Canada, Dept. of Interior

Under favourable conditions, lowland fir may attain a diameter of from 3 to 4 feet and a height of 125 to 175 feet, but it is usually from 1½ to 3 feet in diameter and from 80 to 125 feet in height. It seldom grows in pure stands, but is mixed with other species, more often with hemlock, spruce and cedar. It is less tolerant of shade than amabilis fir, red cedar or hemlock, but more tolerant than Douglas fir. In the larger trees, the trunks are usually very clear of branches and knots. It reproduces abundantly, especially on moist soils in which there is considerable humus. Under favourable conditions it grows rapidly.

AMABILIS FIR—(*Abies amabilis* [Loud.]—Forbes)

The names white fir and silver fir are frequently applied to this species. It is a more northerly species than lowland fir, with a range extending from Oregon to southern Alaska. It is confined, however, to the western slope of the Coast and Cascade mountains and the adjacent islands.* In the southern part of the coast, it is usually mixed with hemlock in a zone above the Douglas fir-red cedar type; but, in the north, it is more prevalent in the valley bottoms, where it sometimes forms almost pure stands.

The distinguishing features of amabilis fir, as compared with lowland fir, are that the leaves are often blunt-pointed, though sometimes notched, and the cones are dark purple in colour, 4 to 5½ inches in length by 2¼ to 2½ inches in thickness.

In British Columbia it grows to from 3 to 4 feet in diameter and from 100 to 125 feet in height, but is usually from 1½ to 3 feet in diameter and 75 to 110 feet in height. Well stocked stands, in which amabilis fir predominates, frequently yield from 30 to 50 M. per acre.

It is a prolific seeder and reproduces well in moist situations.

ALPINE FIR—(*Abies lasiocarpa* [Hook.]—Nuttall)

As the name implies, Alpine fir is a tree of high elevations. Throughout the mountainous portions of British Columbia, the dark, dense, spire-like tops of alpine fir are conspicuous features of the landscape. This species follows the mountain ranges from Yukon to New Mexico. It is distributed generally throughout the province, except on Vancouver island, Queen Charlotte islands and the southern coastal region. In the Selkirk mountains, it grows at 7,000 feet altitude, and is typically a timber-line species.

Under the most favourable conditions it is a small tree, seldom over 2 feet in diameter and 100 feet high, and the stands are usually light. The lower leaves are blunt-pointed but not notched, the upper leaves are keenly or somewhat pointed and are distinctively massed and pointing upwards on the top sides of the branches. The cones, which are from 2¼ to 4 inches in length and 1¼ to 1½ inches in diameter, are deep purple, becoming lighter

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* Though Sudworth, in his *Forest Trees of the Pacific Slope*, states that this species is reported from Queen Charlotte islands, the writer doubts the accuracy of this, as he has never seen any species of Abies there, nor has he been able to find anyone who has. If it does occur, it is of no commercial value, as no timber cruiser mentions it.

by the time the scales fall off. It reproduces fairly abundantly and is quite tolerant of shade.

Growing, as it does, at the higher elevations, where other species find it difficult to become established, it is important as a protective cover for watersheds. For lumber and pulpwood it is also of considerable value.

PINES

Five species of pine are found in British Columbia. Three of these, western white pine, limber pine and white-bark pine, are of the white pine class, having 5 needles in a bundle; one, western yellow pine, is of the 3-needles class, and one, lodgepole pine, of the 2-needles class.

Western White Pine—(*Pinus monticola*—Douglas)

The name 'silver pine' has been used for this species, but was never generally accepted. It occurs west of the continental divide in southern British Columbia, northern Montana, northern Idaho, Washington, Oregon and northern California. In British Columbia it is confined to two regions. On the coast it occurs on Vancouver island and the adjacent mainland as far inland as the headwaters of Bridge river, the upper end of Anderson lake, Spuzzum creek, Coquihalla river and Skagit river. In the interior it occurs in the area including Arrow lakes, Mabel lake, Shuswap lake, Adams lake, upper North Thompson river, Clearwater lake, upper end of Quesnel lake, Canoe river, Columbia river, Kootenay river and up Elk river to above Fernie.

Western white pine is one of the finest woods in the province, but its importance is limited by the fact that it forms less than one per cent of the total stand, and is seldom found in sufficient quantities in any region to enable it to command a special market. There is estimated to be 2·7 billion feet of white pine in the province, 1·1 billion feet on the coast, and 1·6 billion in the interior. The total cut in 1915 was 5,057 M.b.f., and, in 1916, 6,816 M.b.f.

In appearance and structural characteristics, western white pine resembles the eastern species very closely. The main differences are that the needles are stouter, more rigid and somewhat longer, and that the cones are larger, sometimes 5 to 6 inches long. The trunk is usually tall, very straight, tapers very gradually and is usually clear of limbs for at least two-thirds of its length. The wood is very light and soft, and makes excellent lumber for inside finish and general construction purposes. Mature trees range from 2 to 3 feet, occasionally reaching 4 feet in diameter, and from 75 to 100 feet high. It is nearly always associated with Douglas fir, red cedar and hemlock; but, on account of its intolerance of shade, it is found usually on hillsides, rocky knolls or around the edges of lakes or swamps where the light can reach it. It never occurs in pure stands, and seldom comprises more than 5 per cent of the timber on any square mile. It is seldom found at altitudes exceeding 2,500 feet on the coast or 3,500 feet in the interior. Western white pine is not a prolific seeder, and the seeds germinate best on exposed, moist, mineral soil. Though the seedlings will stand considerable shade for some years, abundant light is required later for proper development.

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Base map from plate of Map of Dominion of Canada, Dept of Interior

Limber Pine—(*Pinus flexilis*—James)

Limber pine is a small alpine species, seldom exceeding 25 or 30 feet in height. Little is known of its distribution in Canada, but it is reported to occur as a timber-line species in the southern Rockies. It is of no commercial importance.

White-bark Pine—(*Pinus albicaulis*—Engelmann)

This is another alpine species, small in size and unimportant commercially. It is more generally distributed than limber pine, however, and is reported as occurring sparingly at altitudes between 3,000 and 7,000 feet in the Selkirk mountains. In the Rockies it occurs as far north as the headwaters of Parsnip river, and in the Coast mountains it extends to the mountains in the vicinity of Gardner canal.

Western Yellow Pine—(*Pinus ponderosa*—Lawson)

This species has a greater variety of names than any other on the coast. In California, it is now sold as white pine, while in the 'Inland Empire' and British Columbia the name western soft pine is gaining usage in the trade. One of the early names, and one which is still used extensively, is bull pine ; others are yellow pine, red pine, pitch pine and heavy-wooded pine (Eng.).

It is a widely distributed species, ranging from British Columbia to southern California and northern Mexico. In British Columbia, it is confined to the drier regions of the southern portion of the province. It is the most typical tree of the southern part of the Interior plateau. It is found in the valleys of the Similkameen and Nicola rivers, down the Fraser to Nahatlatch river and up to Canoe creek, Bonaparte river, up the North Thompson to Vavenby, South Thompson river, Okanagan lake, Lower Arrow lake, Kootenay lake and up the Kootenay river to Palliser river.

It occurs on dry, well-drained slopes or plateaux, usually between 1,500 and 2,500 feet elevation, but, on exposed southerly slopes, it may extend to 3,500 feet.

It grows in open, park-like stands, usually mixed with Douglas fir, but sometimes alone. Where it occurs at all, it ordinarily comprises at least 50 per cent of the stand. There is estimated to be 4·2 billion feet of western yellow pine in British Columbia, and it is beginning to assume an important place in the lumber production of the province. The cut in 1915 was only 29,766 M.b.f., but in 1916 it increased to 71,783 M.b.f. It does not attain such large sizes in British Columbia as in the southern part of its range. The usual size is from 18 to 40 inches in diameter and 60 to 100 feet in height. The trunk is smooth and cylindrical, with but little taper until the lower crown branches are reached, which are usually at about one-third of the height. The bark of mature trees is marked by broad, shield-like, reddish to yellowish plates. The surface of the plates is made up of small scales. The bark is usually from 2 to 4 inches thick, being especially heavy near the base of the trunk. The thick bark affords protection against damage from ground fires,

which are of frequent occurrence in this forest type, due to the ground cover of grass, which prevails under these open stands.

The leaves, as has been mentioned, occur three in a bundle. They are usually from 4 to 6 inches long, and are borne in heavy, brush-like clusters at the ends of the bare branches. The cones vary greatly in size, but in British Columbia are usually about 2½ to 4½ inches long.

Western yellow pine is a prolific seeder and would reproduce well if it were not for the constantly recurring fires which destroy the seedlings.

The wood is soft in texture, white to creamy in colour, and takes and retains an excellent smooth finish. Though it has been used considerably for railway and other construction, its fine quality renders it suitable for interior or exterior finish, especially for sash and door stock. It is softer and lighter than Douglas fir or southern pine, and is frequently sold in eastern markets for purposes for which only white pine has previously been used.

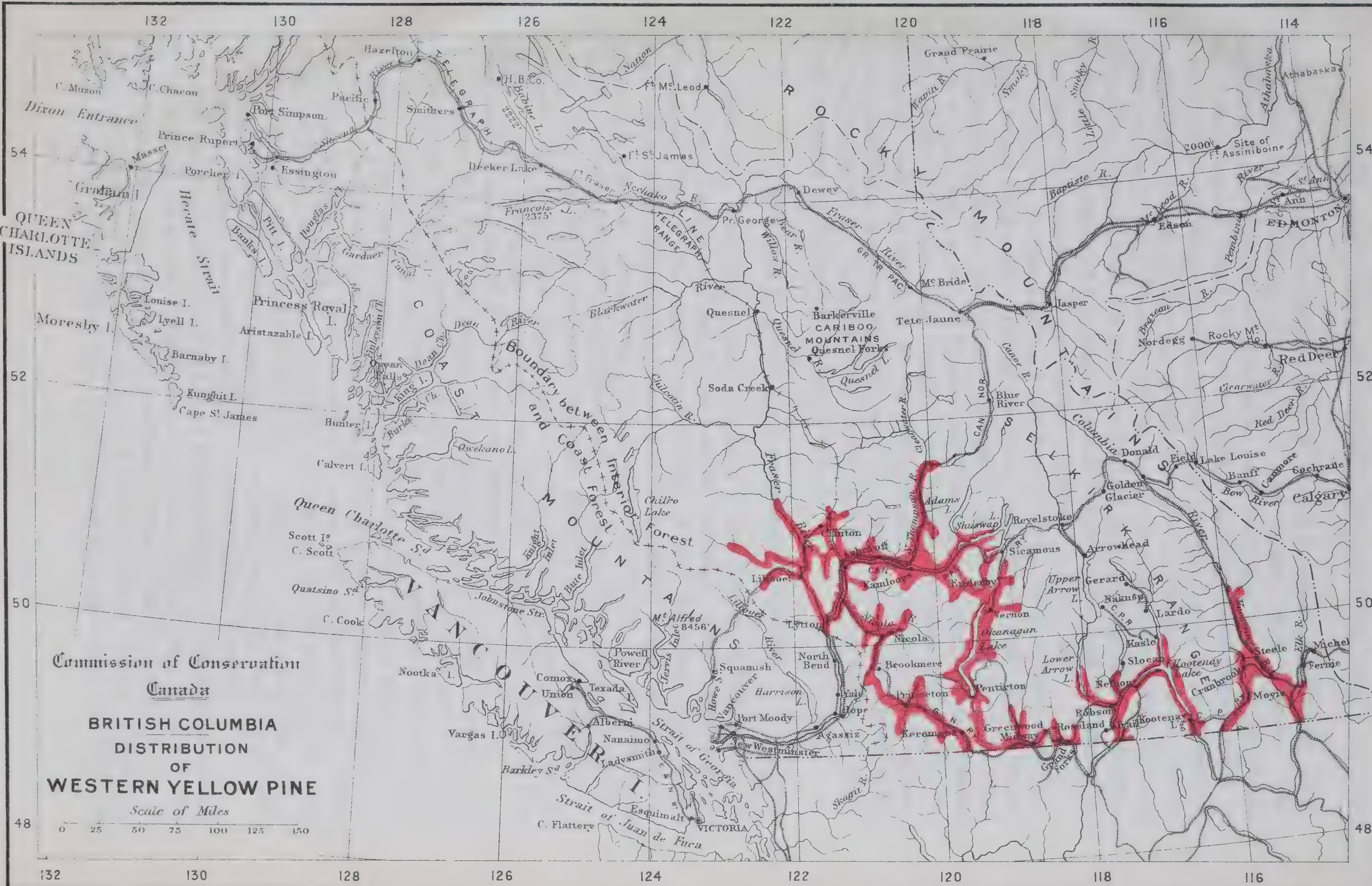
Lodgepole Pine—(*Pinus contorta*—Loudon)

On account of the variable character of this species, botanists have attempted to establish specific differences between the scrubby type, found in the coastal region, and the tall, straight type, which grows in the Rockies. The former is recognized as the typical *Pinus contorta*, and the latter as either *Pinus Murrayana* or *Pinus contorta Murrayana*. As the botanical distinctions all break down when applied generally, it may, for practical purposes, be considered a single species. The name lodgepole pine is seldom used for the coast type, but is applied to the mountain form on account of the tall, slim poles which are found in dense stands of this species. The mountain type is also frequently called black pine or jack pine. On the coast it is generally known as jack pine, black pine or scrub pine.

This species is general throughout the province, from the international boundary to the Yukon drainage. On the coast it is found in swampy places, along the shores of the sea or lakes, or on exposed rocky places, where other species find the conditions too difficult to overcome. Growing thus, it develops a scrubby, knotty form and, except in a few situations, is of little commercial value. Throughout the interior, however, it has become the predominating species over large areas. Its extreme hardiness and ability to reproduce after fire have enabled the lodgepole pine to replace the original stands of fir, yellow pine, spruce and balsam where they have been destroyed by fire. It grows well on sandy and rocky soil from which all the humus has been removed, and, though not a timber-line species, it grows to the lower limits of the subalpine type, at altitudes of from 5,000 to 6,000 feet. Under favourable conditions it may attain a height of from 50 to 75 feet, and a diameter of from 12 to 24 inches.* In dense stands the trunk tapers very little, and may be clear for over half its length.

The leaves are two in a group, from 1 inch to 2 inches long, and stiff. The cones, which are borne in great numbers, closely attached to the branches,

* One specimen found in the Fly hills is reported to have attained a diameter of 25 inches and a height of 110 feet (Dominion Forestry Branch).



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Base map from plate of Map of Dominion of Canada, Dept. of Interior

are, when open, nearly round and from 1 inch to 2 inches in diameter. The cone scales are thickened on the end and tipped with a spine. The cones ripen late in August and September and may open and shed their seeds then or may remain closed for many years, still adhering to the branches of the tree. The wonderful reproductive power of this species is dependent on the ability of the cones to endure a severe fire without injuring the seed, though the tree may be killed. The heat causes the cones to open and, after the fire, the seeds are liberated on the bare ground and good reproduction is secured. Its ability to produce seed at the early age of from 7 years to 10 years gives it a decided advantage in the struggle for existence against fire.

The wood is coarse, hard and not very strong. It is seldom sawn into lumber, but is used chiefly for railway ties, mine props and poles. Recent investigations indicate that it may become a valuable species for the manufacture of pulp, but, as yet, it is not used to any great extent in the processes employed for the other pulp species. In British Columbia, only 6,914 M. was cut in 1915 and 3,088 M. in 1916, principally in the Cranbrook district. On the coast there is estimated to be only 68 million feet of commercial value, but, in the interior, lodgepole pine forms 8·6 per cent of the total stand. There is nearly 12 billion feet in the province.

Western Larch—(*Larix occidentalis*—Nuttall)

The larch is frequently called tamarack and sometimes hackmatack. In British Columbia it is confined to the southern interior portion, occurring east of Okanagan lake, in the vicinity of Shuswap, Mabel and Sugar lakes, Kettle river, Arrow lakes, Slocan, Kootenay and Windermere lakes and Kootenay river, as far north as Cross river. It is generally found on the upper benches, at altitudes between 1,800 and 4,000 feet, where it occupies an important place in the intermediate forest type, between the dry yellow pine-Douglas fir type and the Engelmann spruce type of the higher altitudes. It seldom occurs in pure stands, but is usually mixed with Douglas fir, lodgepole pine, Engelmann spruce, alpine fir and western hemlock.

Western larch is the largest larch indigenous to North America, and usually equals Douglas fir in size in the localities where it occurs. It ordinarily attains a height of from 100 to 160 feet and a diameter of from 2 to 4 feet. The bole is very straight and, above the root swelling, tapers very gradually. The crown is usually short, leaving, on the larger trees, a clear log-length of from 60 to 80 feet. The bark on trees of over a foot in diameter is a reddish cinnamon-brown, and, for a considerable distance from the base, is very much thickened (from 3 to 6 inches) and deeply furrowed. This thick bark affords a large measure of protection against fire and very frequently enables the larch to withstand severe fires which destroy the concomitant species.

The leaves, which are from 1 to 2 inches long, are in clusters of from 14 to 30, and are of a pale yellowish-green colour. Unlike nearly all the other coniferous trees, the larches are deciduous. The cones vary from 1 to 1½ inches in length, and are characterized by protruding bracts, which grow below the cone scales. The cones ripen in one year, and begin to shed their

seeds early in August. Western larch is a prolific seeder and the seeds require abundant moisture to germinate. It reproduces best on bare mineral soil. It is very intolerant of shade, even when young, and thus does not succeed in competition with dense reproduction of lodgepole pine, fir or spruce. Given sufficient light and moisture, it grows rapidly.

The wood of the western larch is much superior to that of the eastern larch. It is heavy, hard and strong, and the distinct annual rings produce a beautiful grain when the wood is sawn tangentially, When cut edge-grained, it makes excellent flooring. Though not quite as strong as Douglas fir, it is used for the same purposes, such as structural wood, interior finish, railway ties, etc.

It is to be regretted that western larch is not more abundant in the province. The total stand is estimated to be only about 3 billion feet. It is reproducing well, however, and excellent young stands may be seen on the old burns throughout its range. A good example of larch reproduction may be seen at Sicamous, in the Larch Hills forest reserve. In 1915, the cut of larch was 38,597 M.b.f. and, in 1916, 38,706 M.b.f.

Alpine Larch—(*Larix Lyallii*—Parlatore)

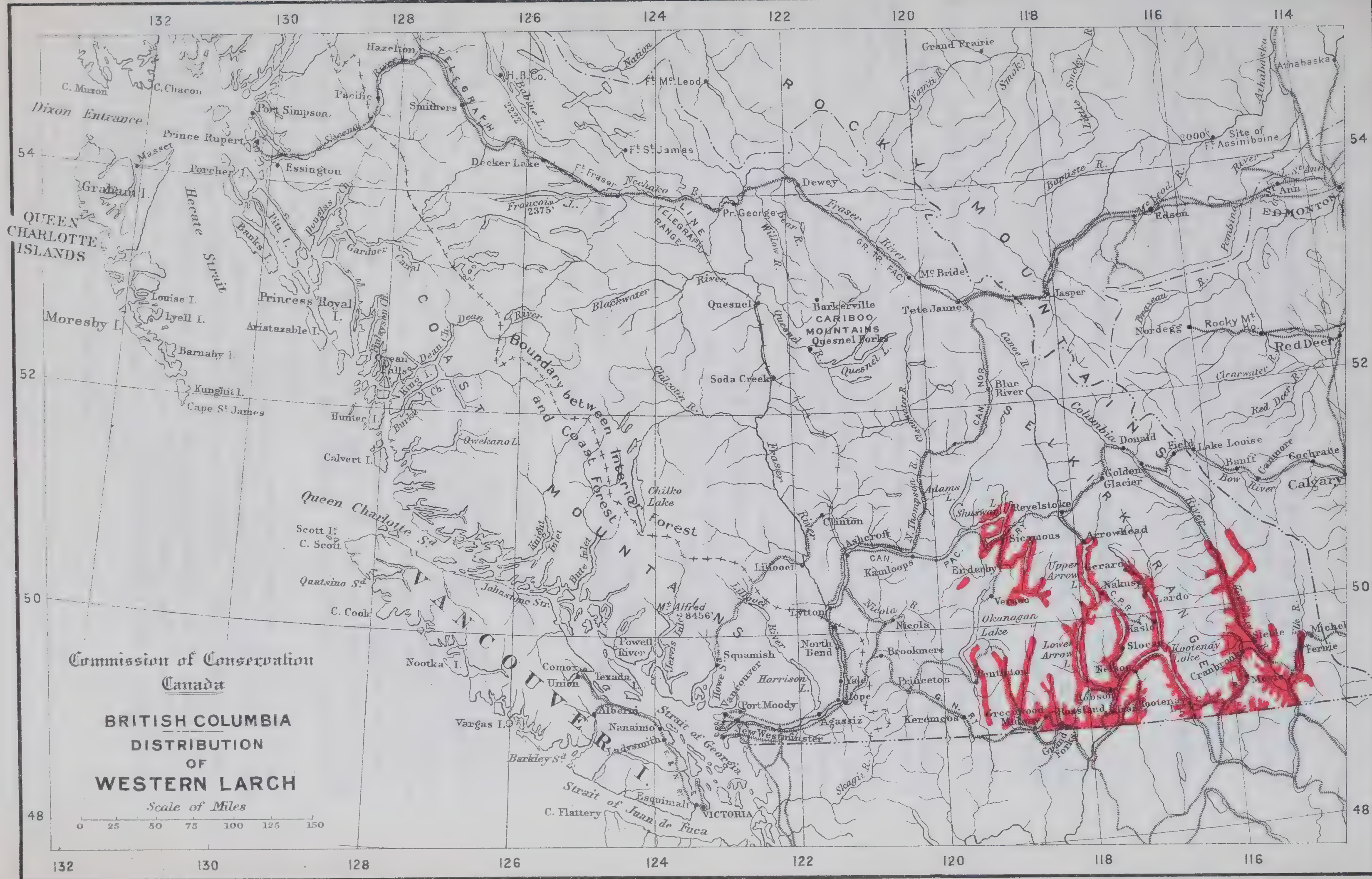
The alpine larch is a stunted species, seldom over 40 feet in height or 24 inches in diameter, and it is usually broadly branched to near the base of the trunk. It occurs only at the higher altitudes, near the limit of tree growth. It has been reported on the eastern and western slopes of the continental divide, at 6,500 to 7,000 feet, northward, to House pass, at the headwaters of the North Saskatchewan river ; eastward, to beyond Canmore, in the Bow valley, and westward, to the southern Selkirk range (between Kootenay lake and St. Mary river) and Galton range (near Tobacco plains, between the continental divide and Kootenay river). It has also been reported in the Skagit drainage, on the west slope of the Cascade mountains.

This species can be distinguished from western larch by the occurrence of from 30 to 40 leaves in a cluster, by somewhat larger cones, the scales of which are deep purple-red, and by the recurved bristly bracts, which are deep purple.

It is of comparatively rare occurrence and is of no commercial value.

Tamarack—(*Larix laricina* [Da Roi]—Koch)

This is the species of larch or tamarack found in eastern Canada. Its range extends from the Atlantic seaboard to the north-eastern corner of British Columbia, where it occurs on the eastern side of the Rocky mountains, in the drainage areas of Peace and Fort Nelson rivers and in the drainage of Liard river, almost as far west as Dease lake, at the head of Dease river. Its usual habitat is in swamps and muskegs or along the banks of streams, where it is accompanied by black spruce.



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Base map from plate of Map of Dominion of Canada, Dept. of Interior

The leaves of the tamarack are in clusters of from 12 to 20 and are about one inch long. The cones are of a pale russet-brown colour and are only about one-half inch long. The bracts are not so long as the cone scales.

The mature tree, in these northern regions, seldom exceeds a foot in diameter and 30 to 40 feet in height. The wood is of value chiefly for railway ties, mine props and fuel.

ROCKY MOUNTAIN JUNIPER—(*Juniperus scopulorum*—Sargent)

This species was for a time considered a western form of the eastern red cedar (*Juniperus virginiana*), and is still sometimes called Rocky Mountain red cedar.

Though a comparatively rare species in British Columbia, it is widely distributed, having been reported as occurring in the following localities :

Eastern foothills of Rocky mountains ; westward through southern British Columbia (here in Columbia River valley, near Donald, shores of Kamloops, François, and other lakes), to Pacific ocean ; here on heights near Vancouver, and at Esquimalt and Departure bay on Vancouver island, and on islands in Georgia strait. A juniper tree found as far north as Stikine river, on Telegraph creek, just east of coast range, is probably this species.*

It is frequently a shrub, but sometimes a small tree, attaining a height of from 15 to 20 feet, with a trunk from 6 to 10 inches in diameter. The minute, pointed scale-like leaves cover the slender four-sided twigs in four rows of alternately opposite pairs. The fruit, which is a clear blue berry, encloses usually two seeds, sometimes only one.

The wood is light, fine-grained and durable. The heartwood is quite red, and the sapwood almost white. There is not a sufficient supply in British Columbia to make it of any commercial value.

WESTERN YEW—(*Taxus brevifolia*—Nuttall)

The yew, as it grows in British Columbia, is frequently a sprawling shrub, but quite often it develops a tree form with a short trunk, occasionally over a foot in diameter. It occurs along the coast as far north as Queen Charlotte islands and Skeena river, and in the southeastern portion of the province in the vicinity of Mabel lake, Upper Arrow lake, Columbia river as far north as the mouth of Canoe river, Kootenay lake and Duncan river, and in the Rocky Mountain trench as far north as Galena. It is extremely tolerant of shade but requires abundant moisture.

The bark of the yew is very thin, rarely over one-quarter inch thick, and is composed of thin, papery, reddish-purple, easily-detached scales. The leaves are flat, two-ranked, sharp-pointed and flexible. The coral-red, berry-like fruit which encloses a hard seed, is from one-quarter to one-half inch in diameter. The wood is fine grained, reddish in colour, fairly heavy and remarkably durable. It is of little importance commercially, but is used locally

* *Forest Trees of the Pacific Coast*—Sudworth.

for making axe handles, paddles, or for other purposes where strength and durability are required.

Garry Oak—(*Quercus Garryana*—Hockes)

Garry oak belongs to the white oak group and has been known as Western white oak, Oregon white oak, Pacific post oak, or Pacific white oak. It is one of the most interesting tree species in British Columbia, since it is the only oak in the province. Its distribution is limited to a small area on Vancouver island, where it attains its maximum development, not at all like a species nearing the limit of its range. It is most abundant in the vicinity of Victoria, where, over small areas, it forms practically pure stands. Extending north along the east side of the island, as far as Nanaimo, and for upwards of 30 miles inland, it is quite a prominent tree on exposed situations. From Nanaimo, it occurs sparingly as far north as Courtenay valley (see illustration). It is found also on the small islands adjacent to the eastern shore of Vancouver island. There is reported to be "an isolated grove on the northwest end of Vancouver island, on Quatsino sound, and another on Fraser river (mainland) 1½ miles above Yale, described originally from the plains around Vancouver on mainland, but not seen there since." * To the south it extends along the coastal ranges to Santa Cruz mountains in California.

Around Victoria it grows to a height of from 50 to 60 feet. The trunk, which is usually unbranched for from 8 to 12 feet, is often from 12 inches to 30 inches in diameter. The stout, gnarly branches usually ascend, imparting a very graceful form to the crown. The most suitable sites for Garry oak appear to be rather dry, rocky, or gravelly, exposed situations, where the annual precipitation is less than 40 inches. It is seldom found in dense stands but is usually found in park-like groves, concomitant with Douglas fir and madrona. It endures shade fairly well in youth, but needs abundant sunlight later. The reproduction does not appear to be keeping pace with the natural decay.

The wood is heavy and strong, and is suitable for the same purposes as those for which standard grades of white oak are used. There is not enough of it in British Columbia to warrant its exploitation and its greatest value is as an ornamental tree.

Madrona—(*Arbutus Menziesii*—Pursh)

The madrona, or arbutus tree, as it is more frequently called in British Columbia, is perhaps the most conspicuous tree on the southern coast of the province. The smooth reddish bark on the trunk and branches furnishes a touch of colour to the otherwise rather sombre foliage of the coniferous forests along the shore. Like the Garry oak, the madrona reaches its northern limit of distribution in the region adjoining the gulf of Georgia. It attains its best development on the eastern side of Vancouver island, a short distance north

* *Forest Trees of the Pacific Slope*—Sudworth. If these isolated specimens exist, which may be doubted, they may have been due to planting by the Indians or white traders. There are no 'plains' around Vancouver, unless the Fraser delta may be so described.

of Victoria. There it grows to a height of from 30 to 40 feet and a diameter of from 12 to 20 inches. It extends along the eastern side of the Island to Seymour narrows and is quite abundant on the islands in the gulf of Georgia and on the adjoining mainland. It is, as a rule, confined to a narrow belt following the salt-water shore-line, and seldom, if ever, grows at altitudes exceeding 1,000 feet above sea level. Throughout the greater part of its range in British Columbia, it does not attain tree form, but belongs to the shrubby undergrowth associated with salal and huckle-berry bushes. It appears to grow on all kinds of soil, from rich bottom lands to almost bare rocks, but is generally found on exposed rocky situations where the soil is shallow.

The trunk is seldom straight for more than a few feet, and the limbs are very crooked. The bark on the smaller trunks and branches is thin, smooth and quite red, peeling off in thin, irregular flakes. On the older trees it often becomes rough and scaly near the base. The leaves, which are evergreen, are broadly oval, from 2½ inches to 5 inches long, thick, leathery, shiny dark green above and whitish beneath. The brilliant orange red, berry-like fruit, which is frequently borne in abundance, is very beautiful in the autumn. The wood is heavy, dense, fine grained and, when dry, is hard. It is not used commercially, but is said to be excellent for cabinet work or for making charcoal. The madrona is used to some extent for ornamental planting, for which purpose it is very effective.

Broad-leaf Maple—(*Acer macrophyllum*—Pursh)

The broad-leaf maple is the only large maple indigenous to the Pacific coast. Though confined to the Coastal belt, its range extends from southern California to the southern end of Alaska. It is quite abundant in moist valleys on the British Columbia coast. Though sometimes found as a pioneer growth on hillsides laid bare by slides or fire, it rarely occurs at altitudes exceeding 1,000 feet.

It occasionally grows to a height of from 60 to 80 feet, though usually less than 50 feet, and the trunk, usually 1 to 2 feet in diameter, sometimes exceeds 30 inches. Ordinarily, the main trunk is short, the large twisted branches spreading broadly. When subjected to shade on the sides, however, it sometimes produces a good clean bole for 15 to 25 feet. The most conspicuous feature of the tree is its very large leaf, which is usually not less than 6 inches, and, frequently, is over a foot broad with stems 6 to 12 inches long. The wood is hard, fairly strong and can be used for flooring and other purposes for which the eastern maples are used. Since hardwoods are so scarce on the Pacific coast, one would expect this maple to be used to a greater extent than it is. Only 3,000 b.f. is reported as having been cut in 1916 in British Columbia. The broad-leaf maple grows very rapidly, and is used extensively for ornamental planting.

Vine Maple—(*Acer circinatum*—Pursh)

This is a small tree, often shrub-like, and seldom over 25 or 30 feet high, with a crooked, often sprawling, trunk from 2 to 8 inches in diameter. It

occurs on Vancouver island and the adjacent mainland, extending up the valleys well into the Coast mountains. It is found at the headwaters of Skagit river and throughout the valley of Lillooet river and Harrison lake. It grows, as a rule, on moist, rich soils, such as alluvial bottoms, flats, benches and along streams. It is commonly associated with alder, forming dense thickets. These species are usually the first to cover the ground laid bare by mountain slides, providing there is sufficient soil and moisture for their growth. Vine maple is extremely tolerant of shade, but it reproduces only moderately well. The leaves are from 2 to 5 inches in diameter, almost circular in outline, with from 7 to 9 acute marginal lobes. It is one of the few British Columbia species which has very brilliant autumnal coloration. In early autumn the leaves of this species turn to colours ranging from yellow to bright scarlet.

The wood is useful for fuel and some minor domestic purposes, but is of no commercial value.

DWARF MAPLE—(*Acer glabrum*—Torrey)

This is a small species, seldom reaching 25 feet in height. It is sparingly distributed all along the coast as far north as Lynn canal and throughout southern British Columbia. It grows in moist situations at higher altitudes, sometimes up to 5,000 or 6,000 feet in the southern portion of its range, and descending to sea level in Alaska. It is the most prominent maple in the Rocky mountains and has been called mountain maple. Dwarf maple can be distinguished easily from vine maple by its deeply three-lobed leaves. It is, like vine maple, of some local use, but of no commercial importance.

ASPEN—(*Populus tremuloides*—Michaux)

Aspen, or poplar, is one of the most widely distributed of our forest trees. It occurs throughout British Columbia, but is not abundant on the coast. It is a short-lived tree and, as a rule, forms an important part of the temporary stands which succeed forest fires.

The bark, except at the base of the larger boles, is smooth and whitish, marked with pale green or yellowish areas. The shiny, trembling, ovate leaves are characteristic of aspen wherever it is found.

On some of the higher parts of the Interior plateau, and in the northern portion of the province, it forms a considerable proportion of the forest cover. It is of little value for lumber, even when large enough, but it makes good pulpwood, and may be used for this purpose when this industry is established in the interior of the province. Practically the only uses to which it is put in British Columbia at present are for fuel and building poles. The sapwood, which comprises the larger portion of the wood, is white, soft, brittle and not durable in contact with the ground. The small core of heartwood is pale brown. It is very susceptible to fungus attacks and is usually unsound by the time it attains saw-timber size.

No figures are available as to the amount of aspen growing in the province, since it forms a very insignificant portion of the forest resources.

PACIFIC GREAT EASTERN RAILWAY, THROUGH CHEAKAMUS CANON

BALM-OF-GILEAD—(*Populus balsamifera**—Linnæus)

Balm-of-gilead, or balsam poplar, as it is frequently called, is a northern species, extending across the continent from Alaska to Newfoundland. Very little definite information is available as to its occurrence in British Columbia, but it is supposed to be confined to the plains region east of the Rockies and to that portion of the province lying north of latitude 56° and west of the Rockies. It resembles black cottonwood, but is not so large. The buds are conspicuously large and coated with a sticky, yellowish, pungently fragrant balsam. The wood is very similar to that of cottonwood, but is more inclined to be defective. It is not an important species commercially, as it is very limited in quantity.

BLACK COTTONWOOD—(*Populus trichocarpa*—Torrey and Gray)

This species is known sometimes as balsam cottonwood, but usually simply as cottonwood. Black cottonwood is a western species, not unlike the common cottonwood, which occurs from the Atlantic seaboard to the eastern side of the Continental divide.

It is the largest and, commercially, the most important broad-leafed species in the province. Trees 80 to 125 feet high and from 3 to 4 feet in diameter are not uncommon, and even larger sizes are occasionally seen. The trunks are usually straight, and, on the larger trees, clear for over half their length. The bark is pale gray, deeply and regularly furrowed, and on the larger trees about 2 inches thick. The young twigs are distinctly angled, later becoming round, shiny and reddish yellow. The buds are very large and covered with a sticky, fragrant gum. The leaves are broadly ovate and from 3 to 4½ inches long. When mature they are thick, leathery, shiny deep green above and silvery white with rusty areas beneath. The wood is light brown in colour, soft, straight-grained, strong, tough and odourless. The latter characteristic gives it a special value as box material for food products, such as butter, cheese, and fruit, since the other local commercial woods are all coniferous. It is easily worked and takes a beautiful finish. It is in demand for carriage and automobile bodies, and to some extent for furniture. Its great strength, in comparison with its light weight, renders it especially valuable for the manufacture of laminated wood products, and it is used more than any other wood in the province for this purpose.

In British Columbia it is not used to any great extent for pulp, but, when pulp manufacture was commenced in the Pacific states, it was thought that an admixture of cottonwood was essential in the production of all kinds of paper ; later, other species were substituted. It is, however, still considered

* Mr. J. M. Macoun, Botanist, Geological Survey of Canada, writing under date Nov. 8, 1918, says : "*P. trichocarpa* is confined in Canada to southern British Columbia, while what has passed under that name and as *P. balsamifera* in the northern part of the province is *P. trichocarpa* var. *hastata*. This variety seen as a tree is very difficult to distinguish from *P. balsamifera*, but is readily separated by its fruit. The tree growing in the Lillooet district, published as *P. Balsamifera* in LeMare's list, is *trichocarpa* var. *hastata*. The cottonwood, which grows to be such a fine tree along the Skeena at Hazelton, is also this variety."

indispensable in the manufacture of soda pulp for high-grade paper. As mechanically ground pulp it produces a fairly long, strong, white fibre.

Black cottonwood is typically a pioneer species on alluvial soils. It is usually the first tree to become established on sand banks or other alluvial deposits. It has a powerful influence in the fixation of these soils. Later, when the soil becomes sufficiently built up, spruce, cedar, hemlock or fir replace the cottonwood. It is found, however, in nearly all the larger valleys in the province, along the river banks, and on the newer soils of the islands, but is seldom seen along the salt-water shore. In some of the valleys, such as those of the Fraser and Columbia rivers, where there are large areas of bottom-lands, cottonwood becomes an important part of the stand. Where it occurs at higher elevations in moist cañons it does not attain the large sizes found on the river flats.

Estimates of the stand of cottonwood are considered as only approximate, but since it usually forms such a small percentage of the stand it is ignored by the cruisers. However, it is thought that there is about 750,000* M.b.f., about two-thirds of which is on the coast. The cut in 1915 was only 1,045 M.b.f., and in 1916 1,944 M.b.f. The demand for cottonwood will no doubt increase as the pulp and other specialized industries, such as veneer, cooperage, and box manufacture are developed.

Birch

Four species of birch are reported in British Columbia—western birch (*Betula occidentalis*—Hooker), Alaska birch (*Betula alaskana*—Sargent), mountain birch (*Betula fontinalis*—Sargent), and paper birch (*Betula papyrifera* —Marsh). Much still remains to be determined concerning these minor species of trees, not only in regard to their distribution, but also as to their botanical classification. The birches of British Columbia, with the exception of *B. occidentalis* and the western varieties of *B. papyrifera*, are all small trees occurring sparsely and are of little or no commercial importance. *B. occidentalis* has recently been reduced to varietal rank and is now treated as a variety of *B. papyrifera* by most British and American botanists. Other well defined varieties of *B. papyrifera* are var. *subcordata*—Baker and var. *kenaica*—Henry. These varieties are so difficult to separate by anyone but a specialist that they may be treated together as western birch, a tree which reaches a height of 80 or 90 feet and a diameter of from 2 to 3 feet in favourable localities on both the coast and in the northern interior of British Columbia, especially in the valleys of streams running into the Fraser from Lillooet northward and in the valley of the Skeena. In the Skeena valley, in the vicinity of Hazelton, there are some very fine trees which, according to Dr. Sargent, who has examined specimens, include both the var. *occidentalis* and the var. *kenaica*. Some fair-sized trees are also to be still found in the lower Fraser valley, along tributaries of the upper Columbia and on Vancouver Island. Whether true *Betula papyrifera* occurs in British Columbia or not is very doubtful unless

* Including the *P. trichocarpa*, var. *hastata*.

it be north of the Grand Trunk Pacific railway. The western birches of the B. *papyrifera* group are evidently a remnant of what was once a more important deciduous forest and where found growing now they should be carefully preserved.

Alaska birch is a small, northern species, usually 25 to 30 feet high. The bark is occasionally white, but usually light reddish-brown. It occurs throughout the north-western plains, and crosses the northern portion of the province to the Pacific coast, but probably does not occur south of Stikine river.

Mountain birch is a small tree or shrub, 10 to 15 feet high. The bark is shiny and old-copper coloured. It is reported by Sudworth as occurring "throughout British Columbia, from upper Fraser and Peace rivers, and probably farther north, southward and eastward over the continental divide to eastern Rocky Mountain foothills in Alberta; extending eastward, also, down Saskatchewan river to Edmonton. Not detected west of Coast mountains. Locally noted on Columbia river from Golden to Selkirk summit." It is also reported as being common along the Athabasca river in Jasper park.

Alder

On the Pacific coast there are several species of alder, which develop into fairly large trees.

Red Alder—(*Alnus oregona*—Nuttall)

The largest species of alder is the red, or Oregon, alder. It is a coastal species, extending from Alaska to California, but some very fine trees grow as far inland as Lillooet and Hazelton. In British Columbia it frequently attains and sometimes exceeds a height of from 35 to 40 feet and a diameter of from 12 to 18 inches. It is a quick-growing, short-lived tree, found usually on alluvial soils, along streams or moist hillsides, where the coniferous forests have been either destroyed or have not yet become established. As a rule, it is associated with cottonwood or maple in a temporary type.

The trunk of red alder is usually well defined, fairly straight and clear of branches for one half or more of its length. In dense stands, as it is very frequently found, it forms long, straight poles. The bark is thin, smooth, light ashy gray or whitish. The leaves are ovate with serrated margins, ordinarily from 3 to 5 inches long. The upper surface is smooth and deep yellow-green ; the lower surface paler with short, rusty hairs.

The wood is pale reddish-brown, light when dry and not strong. The grain is quite attractive and it is said to be suitable for cabinet work. The chief use, however, is as fuel, for which it is excellent. It is of local importance only and no estimate of the available supply has been secured.

White Alder—(*Alnus rhombifolia*—Nuttall)

This species is very similar to red alder in size and habits. It differs from the latter in having thin, conspicuously-scaly brown bark ; the scaly bark extends considerably higher up the stem than it does on red alder, which is

commonly unbroken and smooth. The leaves of white alder are lighter in colour and more finely toothed on the edges.

Very little definite information is available as to its distribution in British Columbia, but it appears to be confined to the region east of the Coast range.

Sitka Alder—(*Alnus sitchensis* [Regel]—Sargent)

Sitka alder is usually a shrub, but sometimes forms a small tree 20 to 30 feet high. It occurs between sea level and 3,000 feet altitude in Alaska and south through British Columbia to Oregon and to the Rocky mountains in Alberta and Montana.

It is a species of no importance, commercially, and very little is known of it botanically.

Mountain Alder—(*Alnus tenuifolia*—Nuttall)

Mountain alder is a slender alpine species seldom reaching 20 feet in height. It is reported from Yukon (Frances lake) and British Columbia (south to lower Fraser river), through the Rocky mountains, to northern New Mexico and Lower California. It grows in very damp situations, such as around high meadows and lakes at the headwaters of mountain streams.

Oregon Crab Apple—(*Malus rivularis* [Dougl. in Hook.]—Roemer)

This is a small tree, rarely more than 15 feet high, very much branched, and usually forming dense thickets along the edges of lakes and streams. It is distributed along the coast and islands of Alaska and British Columbia, through western Washington and Oregon to California.

Western Serviceberry—(*Amelanchier alnifolia*—Nuttall)

The serviceberry is usually only a tall shrub, from 10 to 15 feet high, with stems rarely over 4 inches in diameter. It has smooth, dull, grayish- or reddish-brown bark. It is distributed generally throughout British Columbia, frequently coming in after fires or growing along the edges of streams, meadows or lakes and in the interior sometimes attains a height of 30 feet and a diameter of 5 inches.

Black Haw—(*Cratægus brevispina*)

Black haw is usually only a low much-branched shrub, but it sometimes develops into a tree from 20 to 30 feet high with a trunk from 10 to 20 inches in diameter. It occurs in moist situations, along the lower mountain streams, in the interior portion of the province. It is reported as occurring as far north as Parsnip river.

The bark is reddish-brown and slightly seamed. The fruit, which ripens in early autumn, is shiny black or black-purple, and is sweet and edible. The wood is fine-grained, brownish-rose-red, with a large proportion of sapwood. No commercial use is at present made of it.

Bitter Cherry—(*Prunus emarginata* [Dougl.]—Walpers)

Bitter cherry varies in form, from a slender-stemmed, much-branched shrub, to a straight, clean-stemmed tree 35 to 40 feet high and from 6 to 12 inches in diameter. It is distributed throughout southern British Columbia, and as far south as Arizona. In the northern portion of its range it grows at from sea level to an altitude of 3,000 feet ; in the south at 5,000 to 9,000 feet. The wood is light and brittle and soon rots when in contact with the soil.

Western Choke-cherry—(*Prunus demissa* [Nutt.]—Walpers)

This cherry has almost the same habits of growth as the bitter cherry, but extends to the northern portion of the province, along the coast and as far as Cache creek in the interior. It has also a wider altitudinal range.

Western Dogwood—(*Cornus Nuttallii*—Audubon)

Western Dogwood resembles the eastern flowering dogwood (*Cornus florida*), and is known chiefly for its large conspicuous white bloom in the spring and its clusters of bright red berries in the autumn. The real flowers are borne in dense clusters and are small, inconspicuous and greenish yellow. Surrounding the clusters of flowers are from 4 to 6 (usually 4) large snowy white bracts which are popularly taken to be parts of the real flower. The trees usually develop distinct, fairly clean trunks from 2 to 6 inches through, rarely 10 to 20 inches. The dogwood is often 20 to 30 feet high, rarely 40 feet. The wood is very pale reddish-brown, with thick sapwood. It is fairly heavy, quite hard, dense and fine-grained, though not so heavy or dense as the eastern dogwood. It is said to be suitable for turnery and small cabinet work, but is very little used at present.

In British Columbia it is confined to the southern portion of the coast (lower Fraser river and southern portion of Vancouver island), but it extends south along the coast to California.

Willow

There are a large number of willows in British Columbia, but few of them are of tree form, and these are of little or no commercial importance.

Western black willow (*Salix lasiandra*—Bentham) occurs in the Selkirk mountains, and is sometimes 20 to 30 feet high.

Long-leaf willow (*Salix fluviatilis*—Nuttall) is distributed widely throughout North America, from California and the New England states to the Arctic circle (valley of Mackenzie river). It is sometimes 25 feet high.

Hooker willow (*Salix Hookeriana*—Barratt in Hooker) occurs in the coastal region, from Vancouver island to southern Oregon. It is usually a shrub, but sometimes becomes a tree 20 to 30 feet high.

Silky willow (*Salix sitchensis*—Sanson in Bongard) is found along the coast, from Cook inlet, Alaska, to Southern California. It is nearly always a shrub, but occasionally a tree 20 to 25 feet high.

CHAPTER X

Insect Injuries to Forests in British Columbia*

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Of the injurious agencies affecting British Columbia forests, insects have been only slightly less destructive than fire. During recent years, extensive outbreaks by certain destructive species have resulted in unusually severe injuries with very large quantities of timber partly or completely ruined.

Normal Annual Loss from Insect Injuries

In addition to the more evident outbreaks, where many hundreds of trees die each year in the infested area, there is a very large and often unrecognized annual loss due to the normal activities of forest insects. Everywhere throughout the forest injured, unthrifty and overmature trees are attacked and killed by various species of bark-beetles and wood-borers. The normal loss from this cause is so very great, when large areas are considered, that it should receive serious consideration. When coniferous trees die without any apparent external injury, examination usually shows that death has been hastened or caused by bark-beetles or other insects.

When slashings are allowed to lie, the fresh bark and wood serve as a breeding ground for many destructive insects, and it is therefore only to be expected that the annual crop of scattered dying trees will be abnormally large in the neighbourhood of bodies of neglected recent slash. It unfortunately happens that nearly all these dying trees are completely destroyed by the grubs of boring beetles in the first two years following their death, and become an absolute loss, since, even though the limit is being logged, it is usually unprofitable to collect the scattered dying trees. Properly conducted slash-burning will almost invariably reduce the amount of this annual loss and must be regarded as a most valuable method of insect control.

Light burns also provide an abundant supply of dying bark for breeding purposes. The injured and slightly burned trees are as dangerous beetle-breeding grounds as is the slash; and this should be considered when the burns are being logged. If the fire has occurred in the first half of the season and has charred only the bark near the ground, the timber on a burn must be cut during the first winter following the fire, or, at most, not later than the second winter, if anything is to be saved.† Since the logs will contain living

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* This chapter was contributed by J. M. Swaine, Chief, Division of Forest Insects, through the courtesy of Dr. C. Gordon Hewitt, Dominion Entomologist, and Consulting Zoologist, Entomological Branch, Dept. of Agriculture, Ottawa.

†Excepting the largest timber of the British Columbia coast.

grubs, even though cut the first winter after the fire, they must be got into water or sawed before spring opens ; and, when the latter is done, the lumber should be dried as rapidly as possible. All green slash and small dying trees on the burn should be piled and burned to prevent the breeding of insects. Trees which have been thoroughly charred from base to top may be disregarded, in so far as beetle control is concerned. Burns made late in the season are, of course, frequently immune from beetle injury, although this is true to a smaller degree in British Columbia than in eastern Canada.

Bark-beetle Outbreaks

The most extensive injuries to timber in British Columbia in recent years have been caused by several destructive species of bark-beetles, affecting western yellow pine, lodgepole pine, western white pine, Engelmann spruce, Sitka spruce, lowland fir, alpine fir and western hemlock. The outbreaks in yellow pine, white pine and lodgepole pine have been most extensive and have killed an immense quantity of timber. The infestation is still spreading rapidly, and has already become a most serious menace to the timber areas of southern British Columbia. In the country about Okanagan lake, and between Princeton and Merritt, there are large areas upon which the pine has been already almost entirely killed off by the beetles, and others upon which 50 per cent or more of the pine is now dead or freshly infested this season. These older and more extensive outbreaks, increasing in size each year, are the reservoirs from which the injury is now rapidly spreading throughout the southern pine region west of the Rockies. Small outbreaks are already reported across the summit east from Okanagan lake.

The timber values threatened by these outbreaks are enormous, but are probably not the most important consideration. If the beetles are allowed to spread unchecked, and if large areas of beetle-killed timber are swept by fire, there will be just that much more rock and range land in southern British Columbia.

It is possible, even yet, by the immediate application of practical control measures, to effectively check the spread of the destructive beetles and to prevent further serious injury, but the longer the adoption of this policy is delayed, the more difficult and expensive will be its application. (Written March 14, 1917.)

Bark-beetles in Western Yellow Pine

The western yellow, or bull, pine, *Pinus ponderosa* Laws., occurs in British Columbia only in the southern part of the interior. It is specially subject to attacks by destructive bark-beetles, ambrosia-beetles, the larger wood-borers, and a variety of other injurious insects Since its thick sap-wood is rapidly attacked and destroyed by boring-beetles and stained by bluing fungi, the timber of beetle-killed trees should be utilized at once.

Throughout its range in British Columbia, the western yellow pine is subject to attack by three destructive species of bark-beetles, and by many species of less importance. The western pine bark-beetle, *Dendroctonus brevicomis*—Lec., is one of the two most injurious ; the western white pine, or

mountain pine, bark-beetle, *D. monticolæ* Hopk., is as serious an enemy to the yellow pine in British Columbia as it is to the western white pine, or mountain pine, from which it derives its name ; and the red turpentine bark-beetle, *D. valens* Lec., works in the inner bark about the base of green pines attacked by the two more destructive species just mentioned. Dying trees are also found in which the last-named species seems the chief cause of the injury.

The injury caused by bark-beetles results in the death of infested trees, previously sound, in less than one year. Many thousands of trees have been killed by bark-beetles and, later, riddled by wood-borers, since the commencement of the outbreaks about ten years ago. The area seriously affected includes the country about Okanagan lake, and westward to beyond Merritt and Princeton. Serious injury by the beetles, as evidenced by dying and dead pine in clumps or as isolated trees, may be noticed in many parts of the infested area, but the most serious injuries have occurred in the valleys west of Peachland and in the neighbourhood of Princeton. In some sections practically all the pines are killed, but, usually, the infestation is evidenced by small or large clumps of dead trees (called 'red-tops' until the needles fall) with numerous dying and dead trees scattered throughout the infested area. The injurious beetles, with their broods, feed within the bark of the infested green trees. They attack the trees during July, and, by the following June, the tree is dead and reddish in colour. The beetles which have bred in the bark then leave the tree to attack others nearby, or, as frequently happens, they may travel in great numbers and settle upon trees at a considerable distance from the parent trees.

Western Pine Bark-Beetle

This is one of the two injurious species concerned. It is a cylindrical, hard-shelled beetle, from two-sixteenths to three-sixteenths of an inch in length, and varies in colour from light-brown, when recently transformed, to nearly black when mature. It is clothed above with very short, inconspicuous hairs. The young are small, whitish, footless grubs, with powerful jaws, found boring chiefly in the outer portion of the inner bark.

Life History and Habits—The beetles enter the green bark of healthy, injured, or recently felled trees in pairs during the summer months, and excavate long, irregularly winding egg-tunnels, mostly upwards from the entrance-hole, through the inner bark, upon the wood-surface. A portion of the red boring-dust and excrement is thrust from the entrance-hole and lodges in the bark crevices below ; the remainder blocks the egg-tunnels. When the attack is made upon green, healthy trees, the exuding resin forms in irregular masses about the entrance-hole, and drops fall and adhere to the bark below The male beetle keeps the entrance free through this mass of gum, which is known as the 'pitch-tube' or 'resin-tube.' The presence of these resin-tubes upon the bark of injured trees indicates positively that the tree was attacked while the bark was green and full of fluid resin.

The eggs are deposited singly in shallow niches, cut by the female along the sides of the egg-tunnel at intervals of a half-inch or more ; and the young

larvæ, or grubs, which hatch from the eggs in about eight days, bore irregularly, mainly in the outer layers of the inner bark. When nearly full-grown, the grubs bore outwards and deep into the middle layers of bark, enlarge the ends of the tunnels to form 'pupal-cells', and there transform to the resting-stage or pupa. The adult beetles, which appear later from the pupæ, bore round holes through the outer bark and escape to spread the infestation to green trees, or to increase the numbers in the trees already infested.

Many of the beetles attack the trees near the 'red-tops' from which they escape ; but swarms, spreading from the old infestations, attack isolated trees and small clumps at a considerable distance. The outbreak thus spreads by the increase in the number of the clumps and scattered infested trees, as well as by the enlargement of the individual clumps.

Seasonal History of the Broods—In British Columbia there are one brood and a partial second one each season. During the winter, there may be found in the bark the parent adults of the autumn brood, young, light-coloured adults still in the pupal-cells, and many larvæ, or grubs, in various stages.

When the weather becomes warm in spring, the over-wintered parent adults extend their tunnels, or start new ones, and deposit eggs. The adults developed from these eggs appear, it would seem, early in August and start tunnels in the trees already attacked by the broods of over-wintered young adults.

The over-wintered young adults emerge from the 'red-tops' during July, and attack green timber about the old 'red-tops,' or spread to isolated trees or clumps. By the middle of August, the bark of the trees attacked is filled with larvæ, of all sizes up to nearly full-grown, and the foliage, while not yellow, appears slightly faded, so that such trees can usually be picked out as unthrifty, and, later in the autumn, they are distinguished by the yellowing foliage. They can usually be distinguished by the resin-tubes which stud the bark by hundreds, although it often happens that most of the resin-tubes are high up in the trees and are difficult to distinguish from the ground. This fact should be remembered when marking infested trees for cutting. The larvæ of this brood pupate, and, in most cases, leave the bark as adults before the end of September. These adults, apparently, start fresh tunnels in the same trees, and deposit eggs, the larvæ from which are to be found in the bark during winter.

Western White Pine Bark-beetle

This species is the most destructive of our bark-beetles. It has killed large quantities of white pine and lodgepole pine in various parts of the Province, and in at least some parts of the beetle-infested yellow pine area it is even more destructive to yellow pine than the western pine bark-beetle.

It is a cylindrical, black, rather stout beetle, somewhat larger than the western pine bark-beetle, ranging from 4 mm. to 6.5 mm. (one-sixth to one-quarter of an inch) in length, with the thorax wider than long, distinctly narrower in front, punctured and hairy on the sides and above ; the elytra (wing-covers) with striæ of medium-sized punctures, the interspaces roughened, sparsely clothed with short hairs and with scattered long hairs behind. It is

distinguished from the western pine bark-beetle by its larger size (usually), the wider pronotum narrower in front, the long hairs of the sides and hinder part of the elytra, and by the different shape of the egg-tunnels.

Life-History and Habits—The adult beetles leave the 'red-tops' from the latter part of June onwards, and start their egg-tunnels in the bark of the trunks and larger branches of dying trees, recently cut logs, or of healthy timber. Each pair of beetles cuts an entrance-hole through the bark to the wood-surface and the female excavates an elongated, somewhat straight, egg-tunnel upwards through the inner bark, slightly engraving the wood. The eggs are placed singly in shallow niches, which are arranged along the sides of the egg-tunnels in small groups of three or four niches, with a space of about half an inch between the groups. The eggs composing a group are close together and often covered by a common layer of boring-dust. The grubs, or larvæ, which hatch from the eggs bore the larval-mines mainly through the inner bark. They finally enlarge the end of the mine to form an oval pupal cell, usually between the bark and the wood. After changing to pupæ in the pupal cells and later transforming to adults they finally bore round holes through the bark and escape. Much red boring-dust is extruded from the entrance hole, and, in green trees, resin-tubes form about the opening.

This species normally prefers dying bark, and, when such is obtainable from fires, storms, or slash, the green timber is less likely to be attacked ; but, when the beetles are in large numbers, they readily enter and kill healthy green trees.

Detailed History of the Broods—The winter is passed in the bark of the trees infested during the previous summer, as larvæ, young adults and parent adults.

The over-wintered parent adults lengthen their tunnels, or excavate new ones in the infested trees in spring, and deposit eggs which develop to adults probably in July and August.

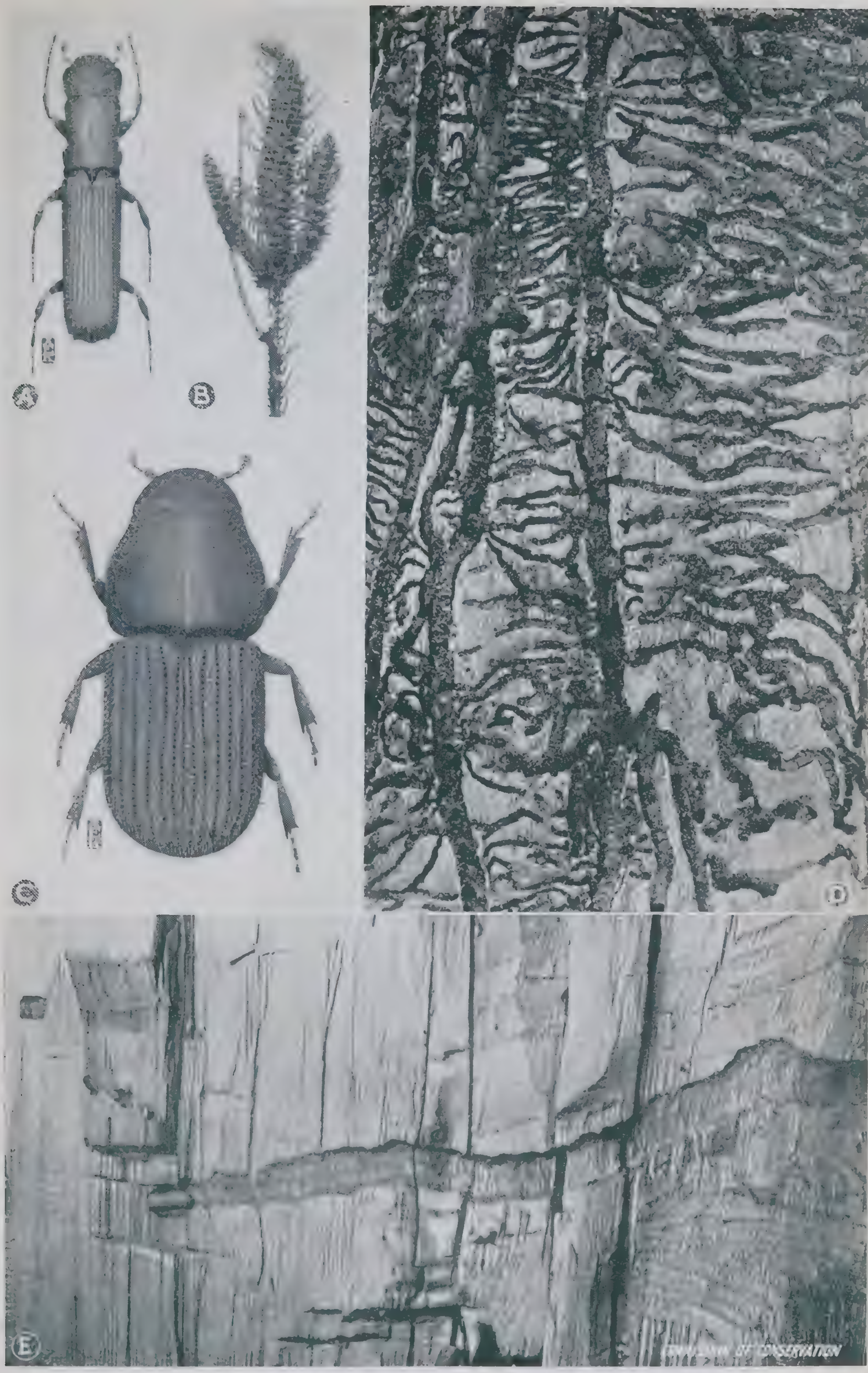
The over-wintered young adults emerge from the 'red-tops' and start egg-tunnels during late July, August and early September. The larvæ of this generation in part develop to adults, but the greater number winter in the bark as larvæ.

The over-wintered larvæ transform to adults which, in British Columbia, apparently emerge during late summer. There is thus one complete cycle each year.

Effect Upon the Trees—The tunnels of the adults and the larval mines kill the inner bark, and, if the greater portion of the trunk is infested, the tree dies in one year. The foliage of infested trees usually remains green until late autumn or spring, fading during autumn and spring to yellow and finally to red by mid-summer. If only a portion of the bark is affected at first, the remaining bark is usually attacked in the following summer, or during the same season, by later-appearing beetles.

The infested trees are to be distinguished by the gum-tubes upon the bark of the trunk, the red boring-dust extruded from the tunnels, the work of woodpeckers on the bark and, later, by the fading foliage. The foliage

Plate XXVII



INSECT ENEMIES OF THE FOREST

A. Pacific Coast Timber Beetle, *Platypus wilsoni* (Sw.); enlarged to 7 times natural size.
B. Galls of the Western Spruce Gall Aphis, *Chermes cooleyi* (Gill); on Sitka Spruce; Stanley Park, Vancouver.
C. The Western White Pine Bark-Beetle, *Dendroctonus monticolae* (Hopk.); enlarged to 14 times natural size.
D. Inner face of bark from a beetle-killed Western Yellow Pine, showing Egg-tunnels and Larval-mines of the Western White Pine Bark Beetle; slightly reduced.
E. Tunnel of a destructive spruce timber borer, the Black Sawyer, *Monohamus scutellatus*, passing directly through the heart of a White Spruce log; reduced to one half natural size.

frequently remains nearly normal in appearance until spring ; but, as many trees fade more or less during the autumn, they may be picked out as unthrifty. In selecting infested trees for cutting, the resin-tubes and boring-dust on the bark and the yellowing foliage must be depended upon. It not infrequently happens that trees are attacked only in the upper and middle portions. The resin-tubes are usually distinguished quite readily, but, when high up the trunk, they are easily overlooked. The selection of the trees will be made most easily during the early autumn, while the gum is fresh and light in colour.

The Red Turpentine Bark-beetle

This species, the largest of our bark-beetles, is from one-fifth to one-third of an inch in length, yellowish to reddish-brown in colour ; the epistomal process broad, with the sides oblique ; the thorax with large punctures, rather regular in size ; the elytra sparsely clothed with long hairs which extend nearly to the base.

It is found in British Columbia in stumps and dying trees of western yellow pine, Engelmann spruce and probably other pines and spruces.

This species confines itself chiefly to the base of the tree, within a few feet of the ground. A pair of adult beetles excavate a wide egg-tunnel, about one-half inch in width, through the inner bark, upon the wood surface. This tunnel is more or less elongate, irregularly widened above the entrance-hole and at first usually vertical in standing green trees. Later the tunnel is frequently branched and often extended downwards. The eggs are laid at intervals in layers or irregular elongate masses against the widened side of the egg-tunnel and covered more or less completely with boring-dust.

The larvæ hatch in about ten days, and feed in congress away from the egg-tunnel through the inner bark, leaving a wide, flat cavity, largely filled behind them with reddish excrement.

This species is not so destructive as the two just discussed. It commonly breeds in the bark of stumps and in the base of trees dying from other injury. It does, however, attack and even kill apparently healthy trees, and renders able assistance to the more destructive species in killing the western yellow pine in British Columbia. Its work in sound trees often results in irregular scars about the base, without involving the death of the trees ; and is betrayed by large masses of resin and resin-tubes about the base of the trunk. The species is very widely distributed. It occurs across Canada, from Yukon and British Columbia to Newfoundland and Nova Scotia, and throughout the eastern and western United States and the western portion of Mexico.

Control Measures for Bark-beetle Outbreaks in Yellow Pine

Outbreaks of these and other injurious bark-beetles in British Columbia, if taken in time, can be controlled by logging operations, modified so as to include the trees containing the brood, and employing proper means for destroying the latter. The beetles and grubs pass the winter in the bark of the trunk of trees attacked that season, on which the foliage is still pale-green or yellow, or reddish, and usually with the bark studded with resin-tubes. If over three-fourths of the broods in the infested trees can be killed before they emerge in the early season, the outbreak can be checked ; and, by similar work upon the relatively few trees attacked the succeeding season, can be brought under nearly complete control provided

the entire infested section is treated, so that there will not be extensive re-infestation each year. When only a portion of the infestation can be treated each year, it is usually considered advisable to direct the work towards reducing as rapidly as possible the chief centres of infestation in the whole infested area. What portion of the second year's work should be employed in new territory and how much towards more complete cleaning up on the ground covered the previous winter must be decided by the conditions of the locality.

When it becomes necessary to undertake direct control measures, the broods in the bark of the infested trees can be destroyed by whichever of the following methods is best suited to local conditions :

Floating the Logs—Where water is available, the simplest method is to cut during winter and float the infested logs as soon as cut or as early in spring as possible. This will kill the greater part of the brood.

Sawing During Winter and Burning the Slabs—Where it can be done profitably, the infested logs may be sawn during winter and the slabs, which will contain the brood, burnt before spring opens.

Barking the Trees—It is always possible to fell and bark the infested trees during winter and, when necessary, to burn the infested bark before spring opens. The presence of the greater number of the grubs in the middle layers of bark renders burning the bark necessary in the control of the outbreaks involving the western pine bark-beetle. Control operations must be completed during the period between the first of November and the following June, but should be finished as early in spring as possible.

When it is not possible to utilize the timber profitably, and control measures are necessary to protect valuable holdings against ravages of the beetles, the infested trees should be treated by the cheapest effective method, so as to destroy the contained brood. The heavily infested trees may be cut and burnt or thoroughly charred before spring opens, frequently at less expense than by removing and burning the bark.

This control work has reference solely to the freshly-infested trees, with green, yellowish, or moderately reddened foliage, having the bark filled with the beetles and their grubs, and not to the old 'red-tops' which have been dead for from one and one-half to several years, and from which the beetles have emerged.

It will often be best to combine two or more of these methods in order to complete the control work during late autumn, winter and early spring.

The red turpentine bark-beetle will probably not be found in British Columbia as the sole cause of extensive trouble. When it is assisting the more destructive species in killing timber, control work for the outbreak should include the removal of the bark from the stumps of the infested trees during the winter following the infestation.

In a region where extensive cutting is in progress, sufficient breeding-places are provided by the dying bark of the stumps. When cutting ceases, the beetles may attack the sound trees and cause more or less injury. When the species becomes very abundant in a locality, as evidenced by its borings

in the base of spruce and pine stumps, its numbers should be reduced by the removal of the bark of the infested stumps *during the winter following the infestation.*

Relation of Slash to Bark-beetle Outbreaks

To control the bark-beetles known to be injurious in British Columbia, it is only necessary to reduce the numbers so that the normal amount of dying bark to be found in the woods will suffice for breeding purposes. So far as we know at present, all our bark-beetles prefer dying bark, and it is only when their numbers are very great that green timber is attacked in quantity. It therefore follows that, so long as extensive cutting in a district continues, the slash and stumps serve as a breeding place, and, to a considerable extent, or for a time often entirely, protect the healthy trees. But, unless the amount of slash increases from year to year, certain species are bound to develop to such numbers that additional breeding-places are required ; and then, or, with certain species, before that stage is apparently reached, they attack the surrounding green timber. When cutting ceases suddenly there is always danger that an outbreak may develop in the neighbourhood.

It will be seen from the above that, while slash may serve for a longer or shorter time as a protection to the standing timber from bark beetles, it may become a serious danger, in as much as it offers abundant food supply for the beetles, in which they may breed to immense numbers. We have already seen that the slash almost invariably breeds the injurious wood borers, and many species of bark-beetles which kill tops and branches and weakened trees.

The slash can be made to serve as an effective trap. Many injurious species will pass the winter mostly as young adults or larvæ in the bark. If the slash of the previous summer's cutting is burned during winter and early spring, before the fire season opens, a sufficient number of the beetles will usually be killed to hold the injurious species in check, unless outbreaks have already started. When there is but one brood each season, as with the mountain pine bark-beetle, winter burning of slash of the previous winter's cut will be sufficient. When the western pine bark-beetle is concerned, summer slash burning in early August would assist in its control, in addition to winter burning for the summer's cut. Slash burning would aid greatly in preventing outbreaks by the three pine bark-beetles, and could be made to protect timber almost completely against the Sitka spruce bark-beetle, the Douglas fir bark-beetle, and probably all other bark-beetles in British Columbia.

Injuries to Western White Pine

The western white pine, or mountain pine, occurs in small amount, usually in mixed stands, in many parts of British Columbia, from the Columbia valley to Vancouver island. It is nowhere very abundant, and large and valuable stands are almost unknown. In nearly every place where white pine has been found in British Columbia by the writer, trees have been noticed dying from attacks of the white pine bark-beetle, and all the evidence collected by us goes to confirm our belief that the reduction of valuable white pine forests in British Columbia has been brought about chiefly by the destructive action of this species of beetle. The

indications are that it will eventually, and, before many years, kill the last of the mature white pine in many sections, unless control measures are speedily undertaken.

Injuries to Lodgepole Pine

Lodgepole pine occurs throughout a large part of the interior of British Columbia. It is very seriously affected throughout part of its range by the western white pine bark-beetle, and many thousands of trees have been killed in these outbreaks within the last ten years. It is believed by investigators in the Western States that the beetles of this species, *monticolæ*, which develop in the lodgepole pine, will invariably choose that species of pine for attack, even though the yellow pine occurs in the same stand. If this habit is found to hold in British Columbia—it has not yet been proven in our studies there—it will sometimes be an important factor in arranging control operations.

The lodgepole pine bark-beetle, *Dendroctonus murrayanæ*, is found breeding in slash and dying lodgepole pines in eastern British Columbia, but is not yet known to be a serious enemy there.

Injuries to Douglas Fir

The Douglas fir extends over a very wide area in the southern half of British Columbia, from the eastern foot-hills of the Rockies to the coast and Vancouver island, with a very irregular northern and northwestern limit. The Douglas fir bark-beetle, *Dendroctonus pseudotsugæ* Hopk., is perhaps its most serious enemy, and a number of other species are important secondary enemies, occasionally developing a primary character.

Douglas Fir Bark-beetle

The Douglas fir bark-beetle has been found killing timber in small amount in several places, notably, in Creighton valley (Vernon district), and at Cowichan lake and Campbell river, Vancouver island. The number of trees killed was not large in any instance found ; but such incipient outbreaks should be kept under observation, so that proper control measures may be applied if they should become necessary.

The adult is a reddish-brown or black beetle, from three-sixteenths to five-sixteenths of an inch in length. It is the only species of *Dendroctonus* breeding in Douglas fir.

This species is extremely abundant in Douglas fir slash, and probably occurs throughout the range of its food-plant. Its normal habit is to prefer dying bark, and to breed in the bark of trunks and larger branches of injured and dying trees, and in stumps and slash from cuttings. Occasionally it spreads to healthy timber, and may become a more or less serious enemy. It also breeds in British Columbia in the western larch.

Life-History and Habits—The adults emerge from the old bark during the spring and early summer, and attack dying or healthy bark in pairs. They enter usually through the thinner places, or bark fissures, and excavate elongate, rather straight tunnels between the bark and wood surface, upward from the entrance hole. The female deposits eggs singly, in shallow niches cut in groups alternately on the sides of the egg-tunnel, and covers all with a layer of boring-dust, which later largely fills the egg-tunnels. The larvæ cut their galleries through the inner bark, away from the egg-tunnel, leaving the wide, long and

often rather straight larval galleries packed with concentric layers of reddish boring-dust. The larvæ enlarge the ends of the galleries to form pupal cells, either between the inner bark and the wood, or in the middle layers of bark, and there pupate. They emerge from the bark through round holes cut either from the pupal cells or from cavities caused by the destruction of the inner bark by the larvæ.

Both egg-tunnels and larval mines are usually distinctly engraved on the wood surface. This species hibernates beneath the bark as young adults, larvæ, and parent adults. There is one brood each season, with possibly a partial second brood. The chief emergence of the over-wintered adults, and their attack upon fresh bark, takes place during May, June and early July.

The abundant reddish boring-dust ejected from the entrance tunnels, and lodged in the bark fissures, distinguishes the infested trunks. During the late autumn and spring, the foliage of infested trees fades from green to yellow and finally to a reddish colour before summer. When only a portion of the tree is attacked during the first summer, the remaining portion may be infested the following season. In such cases the foliage may be, in part, decidedly red before the broods have emerged ; though, as a rule, by the time the foliage becomes red and dry, few living beetles will be left in the bark.

Control Measures—This species prefers dying bark, and is everywhere found in slash and stumps from cuttings. As long as cutting continues in a district, the slash and logs usually supply abundant breeding places, and the subsequent treatment of the logs removes many of the broods of the beetles. When the beetles become very numerous, however, they may spread from the slash to surrounding green timber, and this is to be feared if the cutting ceases suddenly. The beetles and their larvæ winter in the bark of the slash and logs, and regular winter slash-burning is therefore an efficient method of control. Such work should be completed between early October and the first of March. When it is required to control this beetle in seasons during which little or no cutting occurs, over three-fourths of the infested trees may be barked during winter ; or the infested logs may be floated, or sawn and the slabs burned before the middle of March. The unbarked portions of the trunk and the slash should be burned during winter.

Injuries to the Sitka Spruce

Sitka spruce occurs in British Columbia throughout the Coast region and on Vancouver island. Its most injurious insect enemies are the Sitka spruce bark-beetle, *Dendroctonus obesus* Mannh., and the western spruce gall louse. The former has been found killing large timber, and is certainly an enemy which is able to be very destructive. The gall louse is widespread and abundant, but probably not of much importance in the forest ; in parks and where spruces are isolated, or in isolated groups, much serious injury is caused by it.

Sitka Spruce Bark-beetle

This species is represented in our collections from Alaska, along the coast and islands, south to the United States boundary. It probably occurs throughout the Sitka spruce area. It evidently prefers the diseased and dying bark of stumps, logs, slash, and

injured trees, but it is found attacking apparently sound timber and proving a destructive enemy.

The adult beetle is black, stout, from seven-thirty-seconds to nine-thirty-seconds of an inch in length, distinctly hairy, with long hairs extending nearly to the base of the wing-covers, the thorax wider than long, with the sides strongly narrowed in front ; the wing-covers with impressed striæ of rather small punctures, and the interspaces of the dorsal portion rough.

The larvæ are stout, whitish grubs, about as long as the adults, with powerful jaws, and are found working in the inner bark of the Sitka spruce.

Life History and Habits—The beetles enter the bark in pairs during spring and summer and excavate rather straight elongate tunnels upwards from the entrance hole between the bark and wood. The eggs are laid along the sides of the tunnel in irregular rows or groups of varying numbers. The tunnel side is grooved for their reception, and they are usually enclosed by a continuous layer of boring-dust. The rows of eggs are frequently more or less distinctly alternately arranged. The eggs are frequently scattered rather sparsely along the tunnel side at first, and later, more eggs may be laid along the same portion of the tunnel between those first deposited. In a specimen before me, the egg-tunnel is about 4·5 mm. wide, with the egg-groove 1 mm. deep. There are tunnels of larvæ two-thirds grown arising from one portion, and, along the same side, between the origins of these tunnels, are numerous eggs, singly and in groups. The larvæ when hatched bore through the inner bark away from the egg-tunnel. Their mines are separate and distinct for a half-inch or less, and then interlace irregularly, so that the inner bark is often entirely reduced to powder. After the larvæ are two-thirds grown their mines tend to become distinct, and separate tunnels are excavated up or down the trunk. The pupal period is passed in the enlarged ends of the larval mines, either in the inner bark or in the middle layers of bark.

When standing trees are attacked, the first broods apparently enter the thinner bark of the middle trunk, and those appearing later extend the infestation to the base of the tree and even upon the larger roots.

Control Measures—Serious outbreaks by this beetle may evidently be controlled, through the destruction of the broods during the winter by any of the methods already recommended. If water is available, the infested logs should be cut and floated between November and the last of March ; or they may be cut during the autumn and winter, sawn during the winter and the slabs burned before April ; or, finally, they may be barked between November and the middle of March and the logs left for later sawing. The removal of the bark from the lower and middle trunk of over three-fourths of the most heavily infested trees in a district should suffice to bring this insect under control. It is not necessary to burn the bark.

It is probable that where cutting is carried on during winter, spring or early summer, the stumps, logs and slash will attract the beetles and protect the green timber. Slash-burning between the first of October and the first of March should prove an efficient control.

Trap trees might be used with advantage to control outbreaks in valuable holdings, at a distance from cuttings. A few trees to the acre cut in the in-

fested area during late winter or early spring should attract sufficient beetles to protect the surrounding timber. These trees must be treated during the following autumn and winter, so as to destroy the broods contained in the bark. A serious outbreak of these beetles in Stanley Park, Vancouver, was controlled by removing and burning the infested trees during winter.

Boring Grubs in Logs and Fire-Killed Timber

The Larger Wood-borers

Logs left in the woods and fire-killed timber are exposed to serious injury by boring grubs, the young of various beetles, which lay their eggs in or upon the dying bark or wood of the trees attacked. The larger grubs, sometimes as long as one's little finger, cut irregular, flattened tunnels through the sapwood, and some species penetrate deep into the heartwood. The injury is too well known to require a detailed description. In sections where these beetles are abundant, medium-sized logs left in the woods unprotected for two years are usually almost completely ruined by their borings. They are most injurious to pine, spruce, and balsam during the first two summers following the death of the tree, and to large Douglas fir logs or trunks after the first two or three years. Pine, spruce and balsam logs, which are sawn the first winter after cutting, are often but little injured, most of the tunnels being removed with the slabs. The most serious loss is to logs and fire-injured timber left out of water unprotected for two years or longer. Logs placed in water or barked within three weeks from cutting will be mostly free from injury. When logs which float high out of water are boomed in quiet water they should be turned about three weeks after being floated. The beetles do not deposit eggs upon bare wood, and the young grubs require the softer inner bark for their first food. Logs which are loosely piled in the open shortly after cutting escape serious injury if the bark is thin and dries rapidly ; this only occurs in thin-barked trees ; large, thick-barked pines being protected very little by this method. Covering the logs thickly with brush affords an almost complete measure of protection and has the advantage of involving only a moderate expense. The logs to be covered should be piled on skidways and given a very thick covering of green boughs so that the sunlight cannot penetrate at all to the logs beneath.

Large Douglas fir logs are attacked after they have been down for a few years by large heart-wood borers, and to ensure against any such injury, these logs and fire-killed Douglas fir timber should be sawn or made into logs, and put in water within the first two or three years following the death of the trees. Barking the logs will not be effective against these heart-wood borers, but will protect the logs from other species which enter the wood during the first two years, if the work is effected within one month from the death of the trees for the summer cut, or before spring opens when the logs are cut in winter.

Ambrosia Beetles

These insects, also known as timber-beetles, or pin-hole borers, are small, elongate wood-boring beetles, which excavate round, black tunnels, the diameter of a pencil lead, for several inches into the wood of dying trees, logs or stumps.

The two most abundant western timber-beetles in conifers are *Gnathotrichus retusus* Lec. and *Gnathotrichus sulcatus* Lec. They are extremely abundant in Douglas fir, western hemlock, balsam and pines. They enter stumps, logs and injured and dying trees ; and although it is certainly not their normal habit, I have rarely found them entering in great numbers the trunks of hemlocks with green foliage and apparently otherwise healthy. The adults are elongate, dark-brown beetles, one-eighth of an inch in length, almost perfectly cylindrical and smooth. The front of the thorax is roughened with scale-like asperities, and the wing-covers are sparsely hairy behind. The adult beetles excavate cylindrical tunnels, about the diameter of a small pencil lead, from four to about six inches into the wood. The entrance tunnel, usually in the depth of a bark-fissure, passes directly through the bark and into the wood for one or two inches ; there branching takes place in a somewhat irregular fashion, though all parts of the set of tunnels extend in the same horizontal plane. Usually one long side-tunnel is cut shortly within the bark, parallel to the wood surface. The meal-like boring-dust and excrement are extruded through the entrance hole. Along the inner tunnels above and below, the females excorate cup-like niches and deposit an elongate egg in each. The larva which hatches from the egg lengthens the niche in which it finds itself into a short tunnel, or larval-cradle, slightly more than its own length when full-grown, and transforms therein to the pupal stage, with its head towards the egg-tunnel. The pupa transforms to the adult in the cradle. The chief food of the larvæ, and an important food of the adults, is a peculiar fungus called ambrosia, which grows in a dense glistening layer upon the walls of the tunnels and cradles. It penetrates the cut wood-cells and grows for a considerable distance along the vessels ; but is entirely saprophytic in its relations to the wood. The walls of the tunnels are stained black for a millimeter or more in thickness. These small, black, round, branching tunnels in the wood are characteristic of the timber-beetles or ambrosia-beetles.

The winter is passed by parent adults in the tunnels, young adults in the tunnels and cradles, and pupæ and larvæ of various sizes in the cradles. Apparently work is continued in these tunnels in the spring, and new tunnels are started by the young adults. A second brood appears and starts fresh tunnels early in August.

The Pacific coast timber-beetle, *Platypus wilsoni* Sw., is abundant on the coast and Vancouver island in the same trees with *G. sulcatus*, and *G. retusus*. Its habits are somewhat similar to those of *Gnathotrichus*, except that the eggs are deposited free in the tunnels, and not in special niches. The tunnels are slightly but distinctly larger than those of *Gnathotrichus*, and penetrate the trunk for from six to ten inches or more, giving off lateral branches. The entrance-tunnel often enters four or six inches before any branching occurs. There is one brood each season in British Columbia. Tunnels which are commenced in August and September contain parent adults and eggs during winter and are completed in the following season.

Its boring-dust, seen in white piles in the crevices below the entrance-holes, is in the form of minute splinters of wood, and quite easily distinguished from the meal-like boring-dust of *Gnathotrichus*.

The adult beetle is about five millimetres (one-fifth of an inch) in length, dark brown in colour, flattened, elongate, with the wing-covers strongly ribbed, and, in the male, produced on each side behind.

The western spruce timber beetle, *Trypodendron confrons* Mamih., as well as other species of ambrosia beetles, are variably abundant.

Economic Importance of the Ambrosia-beetles—A considerable amount of injury is caused by these pin-hole borers, and they are likely to become more numerous in the future, as cutting becomes more extensive. They breed in all dying trunks and recently cut logs and stumps, never in dead and dry wood, and seldom, perhaps never, in perfectly healthy trees. The Pacific Coast timber-beetle is the most injurious, since its tunnels penetrate several inches deeper into the wood. Such injury is chiefly to logs which remain out of the water during summer. The timber-beetles are particularly injurious in the west to fire-injured timber, and about recent burns the little piles of white boring dust, extruded from their tunnels, are spotted over even the thoroughly blackened bases. The inner bark and wood of these trees are, of course, still full of sap, and entrance is made through cracks in the burned surface of the bark.

Control Measures—These insects enter dying trunks and logs in which the inner bark and sap-wood are green and full of fermenting sap, or even barked logs and sawn lumber if the surface is moist, but never through a dry, sapless wood surface. They start their tunnels during the spring and summer months, so that logs cut between April and September are often attacked shortly after being felled. The late autumn and winter cut usually remains sappy until spring and is then readily attacked. Logs cut in the early autumn are not entered that season, and, if piled loosely in the open, often dry sufficiently to be protected from attack the following spring. Logs placed in water are safe from further serious injury. There is little injury when the summer cut is placed in water *as rapidly as produced* and the winter cut floated before the middle of April. Lumber from summer sawing of green logs is partially protected by piling loosely so that the surface dries rapidly.

Western Red Cedar Borer

A very serious injury to western cedar, *Thuya plicata*, is caused by the western cedar borer, a species of *Trachekele*, whose destructive work is abundant in certain sections along the coast.

The borer is an elongate, flat-headed grub, the larva of a beautiful golden-green beetle. The grubs excavate very long, winding, flattened tunnels lengthwise through the heartwood and less commonly in the sapwood of living cedars. The injury extends throughout the trunk from near the base into the branches of the top. It is most commonly found in dead-top cedars, although it has been found in perfectly green trees. There is no evidence upon the surface of the injury to the wood beneath, although the heartwood may be riddled with the tunnels. Even when the timber is made into logs or shingle bolts, the injury is easily overlooked, for the tunnels are flat and filled with boring

dust of the same colour as the surrounding heartwood. The grubs are not found in old dead trees, although their tunnels are common in timber killed by fire many years ago.

The adults appear late in March, and are rarely taken in British Columbia, although the injury by the grubs is so extensive. The grubs pupate usually in the branches or sapwood of the top of the trees, and it is evident that, if the slash from infested trees were burned, many larvæ would be destroyed and the injury for the future proportionally checked. An effort should be made to utilize the grub-injured timber so that it would not be entirely wasted.

Other Forest Insect Injuries

The pines, spruces and Douglas fir are attacked by numbers of other bark-beetle species, usually of secondary importance. As a rule, these secondary species breed in dying bark of slash and dying trees, but have been found occasionally killing green timber. Slash burning will usually hold these species in control.

The western hemlock and the lowland fir are each attacked and killed, sometimes in considerable numbers, by several species of bark-beetles, and the alpine fir is frequently killed by the alpine fir bark-beetle, *Dryocoetes confusus* Sw.

Injuries to Douglas fir timber are caused by the Douglas fir pitch moth; to western hemlock by the western hemlock bark-maggot, to yellow pine tops and to the branches of all pines by pine pitch moths. Certain of these and other injurious species have caused serious losses in some localities.

Cone beetles in pine cones and cone moths in the cones chiefly of pines and Douglas fir have had more or less influence in checking reproduction.

Defoliating insects have always been more or less troublesome in British Columbian forests. In recent years the spruce budworm, the tent caterpillar and the western hemlock looper have been the most injurious.

The spruce budworm occurs periodically in outbreaks on Douglas fir in British Columbia. It destroys the young buds and much of the foliage of the infested trees and more or less seriously checks their growth during the three or four years of the outbreak.

The tent caterpillars affect chiefly the poplars and birch. Extensive outbreaks have occurred in recent years south of Prince George and at several places in the interior and on Vancouver island.

The western hemlock looper defoliates the western hemlock, and the same or a very closely allied species strips the oaks on Vancouver island, and has apparently killed a large number of them. The hemlock looper is most injurious to trees under more or less isolated conditions and its injury is referred to in the section upon Stanley Park.

Insect Injuries in Stanley Park, Vancouver, B.C.

Some years ago, it was noticed that a large number of trees in Stanley park were seriously diseased and that many were actually dying. The matter

Plate XXVIII

WESTERN YELLOW PINE KILLED BY BARK BEETLES, NEAR PRINCETON

HEMLOCK DEFOLIATED AND KILLED BY CATERPILLARS IN STANLEY PARK, VANCOUVER

was brought to the attention of the Entomological Branch late in the summer of 1913, and an examination was at once undertaken. It was found that the chief injuries to the trees were caused by certain insects, and a careful investigation of these injuries was carried out by officers of the branch during the summers of 1914 and 1915. Recommendations were made to the Vancouver Board of Park Commissioners for such control measures as could then be applied. Unfortunately most serious injuries had already been effected and a very large number of trees were already in a dying condition.

The area included within the park is somewhat over 900 acres, and comprises a mixed stand of western red cedar, Sitka spruce, western hemlock and Douglas fir, with a considerable proportion of deciduous species, such as maple, alder, cherry and willow. Much of the larger coniferous timber was removed many years ago, but a considerable number of fine trees still remain. It was found that the injured trees were chiefly Sitka spruce and western hemlock. Many cedars were dead at the top, but this was apparently due to a fungus disease, beyond our control, and common throughout the coast region of the province. The Douglas fir was uniformly healthy.

Injuries to the Sitka Spruce

The Sitka spruce was attacked by the western spruce gall aphis, the spruce green aphis, and the Sitka spruce bark-beetle.

The Sitka spruce gall aphis, *Chermes cooleyi* Gillette, was held responsible for the death of a large proportion of the small spruces in the park and for serious injury to most of those remaining. The injury to the tree caused by these minute insects consists in the development of cone-shaped galls upon the twigs, resulting in the death of the twigs affected, and gradually, when the infestation is heavy, of the entire tree. The forms emerging from the galls on the spruce are winged and migrate from the spruce to the needles of the Douglas fir. Their progeny are without wings and remain upon the fir until the following spring, when they deposit eggs, from which comes a generation comprising both winged and wingless individuals. The winged form returns to the spruce and produces a generation whose progeny remain upon the spruce twigs during winter, and the following spring provide the generation of gall producers. Hundreds of galls are produced upon a single spruce under park conditions, and the injury is accordingly great. The galls are not produced on the fir and apparently no very serious injury results from the feeding of the aphis upon the needles.

Experimental spraying proved that the gall aphis is effectively controlled by spraying with contact sprays ; but so many of the smaller spruces had already been killed or injured beyond hope of recovery that spraying was not undertaken. The trees in a dying condition were removed and burned in the early spring. The largest spruces are also badly infested by the gall aphis, but they will probably be able to withstand the attack.

The green aphis of the spruce, *Aphis abietina* Walk., was discovered, in 1914, seriously affecting the foliage of numbers of the smaller spruce trees in Stanley park. These plant-lice appear early in the season and suck the juice from the older spruce needles, causing many to fall, and very seriously

affecting the appearance and health of the trees. The injury is undoubtedly a serious one, but it has not actually killed trees in the park. It is readily controlled by spraying with contact sprays.

The Sitka spruce bark-beetle was discovered in 1913, breeding in a few unhealthy large spruces on the margin of Beaver lake. In 1914 the number of infested trees had risen from less than six to about twenty-seven, including trees apparently previously in fairly good condition. It was evident that the remaining large spruces in the park were threatened with destruction and it was recommended to the Park Board that the infested trees, then beyond hope of recovery, should be removed during the winter and the broods of beetles in the bark destroyed to prevent the spread of the outbreak. This recommendation was carried out, and the following summer only three infested trees were found. These were treated later and the outbreak completely checked.

Injuries to Western Hemlock

The hemlocks in Stanley park were attacked by the western hemlock looper, *Ellopia fervidaria* Hbn., during the three seasons preceding our first visit late in the summer of 1913. By that time the chief injury had been effected and the outbreak was practically over, although that point could not be definitely determined until the following summer. Many trees had already been killed and a much larger number very seriously or fatally weakened by repeated defoliations by the caterpillars. In the summer of 1914 there was a marked diminution in the numbers of the larvae, and the younger trees along the driveways, almost entirely defoliated in 1913, were returning again to the normal condition. This great reduction in the numbers of the caterpillars was due to natural control by a parasitic tachinid fly, and since 1914, the caterpillars have almost entirely disappeared. The injuries caused by their activities were, however, so serious that a large number of the weakened trees died during 1914 and 1915, leaving large areas covered with dead and dying hemlocks. Not only were these trees extremely unsightly, but they were breeding large numbers of injurious fungi and bark-boring and wood-boring insects, notably the western hemlock bark-beetle, and were a positive danger to the remaining hemlocks. The following recommendation was therefore made to the Park Board :

"The following general recommendation, we believe, embodies the only permanent solution of the problem of producing and maintaining a healthy condition of the tree growth in Stanley park. It should be a definite policy to remove dying and dead trees as soon as their usefulness is gone and so prevent breeding of insects and fungi ; to remove or burn all slash from any cutting operation and prevent the accumulation of dying and dead wood from any cause, preferably by burning it, between the months of October and May; and to replant the areas, large or small, denuded by the removal of dead trees, with Douglas fir. The British Columbia Forest Branch has offered to supervise this cutting and replanting. The hemlock is not thrifty under park conditions and will probably gradually die off, and if it is systematically replaced by Douglas fir the park will gradually assume a permanent healthy condition.

"Insect outbreaks in the hemlock and spruce, similar to those which recently killed so many trees, will undoubtedly recur at intervals ; but, now that

the cause of the injury is known and the proper means of control determined, a prompt application of control measures should prevent any serious injuries."

It was further suggested that the replanting of the denuded areas presented an opportunity for introducing other species of British Columbia trees not indigenous to Stanley park.

PART II

CHAPTER I

Forest Resources of British Columbia

THE primary object of this investigation has been to obtain the most accurate information possible of the extent of the forest resources in British Columbia. A knowledge of the present condition was necessary for two main reasons : First, to guide the Government in its administration of the forests, so that they may be utilized to the fullest extent, consistent with the maintenance of sufficient supplies for continued production ; and, second, for the purpose of directing industry to the sources of supply of the required raw material.

The collection and compilation of the authentic data, required as a basis for this estimate of the forest resources of British Columbia, were not accomplished without difficulty. The province covers an immense area, the land area being, approximately, 353,511 square miles. From north to south it extends 760 miles and from east to west it averages about 470 miles. At least nine-tenths of the province is wild, undeveloped land, and, throughout a large portion, means of transportation are lacking.

The extreme variation in the climatic conditions produces a diversiform forest growth. The mild and moist climate of the southern coastal region results in the production of very heavy stands of Douglas fir and red cedar ; the semi-arid conditions on the Fraser plateau cause open, park-like stands of western yellow pine to predominate. In the extreme north the sub-arctic climate precludes the growth of all but the hardiest species. The mountainous nature of the province, as a whole, also causes local variations in the arborescent flora, which renders it necessary to secure very detailed information before an estimate of any value can be made as to the total stand of timber.

Without the co-operation of the timber owners and timber cruisers, the securing of the data upon which this report is based would have been impossible.* Most valuable information was also supplied by the Provincial Forest Branch, the Dominion Forestry Branch, the Forestry Branch of the Canadian Pacific railway and the Land Department of the Esquimalt and Nanaimo railway.

Though the figures submitted in Chapters II and III, Part II, are, in most instances, given in comparative detail, it must be remembered

* See page 6, Introduction.

that they are only estimates, based on the best information available at the time. Later and more intensive survey will doubtless reveal local inaccuracies, but, since the estimates are based on such a large proportion of actual cruises (about 65 per cent), the total estimates for the various drainage basins represent, with a reasonable degree of accuracy, the amount of merchantable timber in each.

Changes in the standards of cruising timber, which will undoubtedly take place as the value of stumpage increases and the forest industries develop, will tend to increase the proportion of the stand which can be termed merchantable or of commercial value. In this report, accessibility, so far as situation is concerned, has not been considered, since it is such an uncertain factor. The sizes which are considered merchantable vary for different parts of the province, for different species, and for the purposes for which the timber can be used. In this estimate, the term merchantable is understood to include such timber as can be used for the ordinary commercial purposes, such as the manufacture of lumber, shingles and wood-pulp, or as piling, poles, railway ties or mine timbers.

Owing to the marked difference between the geographical, climatic and industrial conditions of the coastal region and the interior or mountain region, it has been found advisable to treat the forests of each region separately.

An attempt has been made to make a general classification of the land from the viewpoint of permanent forest production.

LAND CLASSIFICATION

	Total land area		Productive areas				Unproductive areas			
			Absolute forest land		Agricultural land *		Above merchantable timber-line		Below merchantable timber-line	
	Sq. miles	Per cent	Sq. miles	Per cent	Sq. miles	Per cent	Sq. miles	Per cent	Sq. miles	Per cent
Coast	64,164	17·9	20,590	32·1	3,700	5·8	32,715	51·0	7,154	11·1
Interior	289,347	82·1	123,835	42·8	17,000†	5·9	115,533	39·9	32,979	11·4
Total	353,511	....	144,425	40·9	20,700	5·9	148,248	41·9	40,133	11·3

This classification shows that over one-half (53·2 per cent) of the total land area is unproductive, either for forestry or agriculture. About 5·9 per cent is considered to be of more value ultimately for agriculture than forestry, and 40·9 per cent, though useless for agriculture, is capable of producing forests, and should be devoted to that purpose.

A considerable amount of the land classed as agricultural is at present forested, so that the total amount of forest land in the province is placed at 149,334 square miles, or 42·2 per cent of the total land area. This forest land has been classified according to the stands of timber it supports, and is indicated on the Stand Type map accompanying this report.

* At present partially timbered.
† Includes 5,022 square miles of grass land or very open forest.

CLASSIFICATION OF THE FOREST LAND

	Coast			Interior			Total		
	Area	Land area	Forest land	Area	Land area	Forest land	Area	Land area	Forest land
	Sq. miles	Per cent	Per cent	Sq. miles	Per cent	Per cent	Sq. miles	Per cent	Per cent
Timber-land carrying over 30M. b.f. per acre	3,840	6·0	16·4	} 2,748	0·9	2·2	14,110	4·0	9·5
Timber-land carrying 10-30 M.b.f. per acre	7,522	11·7	32·1						
Timber-land carrying 5-10 M.b.f. per acre	.....	.....	.....	14,105	4·9	11·2	14,105	4·0	9·4
Timber-land carrying 1-5 M.b.f. per acre	.....	.....	.....	23,796	8·2	18·9	23,796	6·7	15·9
Total timber-land	11,362	17·7	48·5	40,649	14·0	32·3	52,011	14·7	34·8
Additional area capable of producing forests (mostly reproduction)	12,085	18·8	51·5	85,248	29·4	67·7	97,333	27·5	65·2
	23,447	36·5	100·0	125,897	43·4	100·0	149,344	42·2	100·0

Only 28,215 square miles, or about 19 per cent of the forest land, is statutory timber-land, as defined by the British Columbia Land Act.* In the interior, however, an additional area of 23,796 square miles carries a light stand of from 1,000 to 5,000 b.f. per acre, which may be considered, at least in part, as merchantable. Stands of less than 10,000 feet per acre on the coast are not considered merchantable.

Of the forest-land, only about one-third now carries timber of commercial value, and on 97,333 square miles of forest-land, the merchantable timber has been cut or destroyed by fire. Previous to 1917, only about 30 billion feet had been cut in the province.† Since most of this timber was cut on the coast and from the heavier stands, the area logged probably would not exceed 2,000 square miles. The forests on the remaining 95,333 square miles have been destroyed by fire. It is estimated that, in addition to the area on which the merchantable timber has been totally destroyed, about one-half of the area still carrying merchantable stands has been seriously damaged. It is estimated, from these figures and the average stands on unburned areas, that the amount of timber destroyed by fire in British Columbia is at least 650 billion feet, or nearly 22 times as much as has been cut by the lumbermen. If this timber had not been destroyed it would represent an asset to the Government, for royalty alone, of over $325,000,000.‡ The value from an industrial standpoint would be many times that amount.

* See page 83, Chapter IV.

† See pages 173-177, Chapter VIII.

‡This figure is based on a royalty of 50 cents per M., whereas the royalty at present varies, with the grades of timber, from 50 cents to 85 cents per M., and provision is made for increases as lumber values enhance. It does not include the stumpage value which the governments secure, in addition to the royalty, from the sale of timber. It is not contended that the value of this timber could be realized immediately, but it would be a real asset, and the annual revenues from rentals, and also, to some extent, perhaps, from royalties, would undoubtedly be increased, since much of the timber destroyed was situated close to transportation, where it would have offered opportunities for investment and exploitation.

Most of this burned-over area is growing up again to forest, but, owing to repeated fires, the land in many places is not fully re-stocked. On portions of this area desirable species are being reproduced, but, over a very large proportion of the burned area, the reproduction is of a less desirable type than the original forest. Thus, throughout the interior, lodgepole pine has, to a very great extent, replaced the Douglas fir and spruce types after fire.

Reliable data concerning the rate of growth of the forests in British Columbia are not available, but a stand of 40-year-old Douglas fir in Washington has been found to have produced an average of 1,000 b.f. per acre per year.* If we assume that the 97,000 square miles, on which young forests are more or less completely established, produces, on the average, only 100 b.f. per acre per annum, the total increment would amount to 6,200 million feet per annum, *or about five times the present annual cut* in the province. The realization of this increment is contingent, however, upon the protection of the young growth from fire. No increment is looked for in the mature stands, since decay will undoubtedly offset any growth that may take place.

The remaining stand of timber in the province is estimated to be as follows :

FOREST RESOURCES IN BRITISH COLUMBIA (estimated)

Species	Coast		Interior		Total	
	Million b.f.	Per cent	Million b.f.	Per cent	Million b.f.	Per cent
Western red cedar	59,949	28·0	18,019	13·2	77,968	22·2
Douglas fir	63,400	29·6	12,573	9·2	75,973	21·7
Spruce (all species)	14,165	6·7	58,899	43·1	73,064	20·8
Western hemlock	51,948	24·2	12,164	8·9	64,112	18·3
White fir (balsam)	19,115	8·9	13,838	10·2	32,953	9·4
Lodgepole pine	68	....	11,793	8·6	11,861	3·4
Western yellow pine	......	....	4,208	3·1	4,208	1·2
Yellow cypress	4,056	1·9	......	....	4,056	1·1
Western larch	......	....	3,152	2·3	3,152	·9
Western white pine	1,083	·5	1,617	1·2	2,700	·8
Cottonwood	516	·2	272	·2	788	·2
Total saw-material	214,300	....	136,535†	....	350,835	....
Piling, poles, pulpwood, etc.	15,465	....	......	....	15,465	....
Total forest resources	229,765	....	136,535	....	366,300	....

It will be seen that, of the species suitable for the manufacture of pulp (spruce, hemlock, balsam and cottonwood), there is 170 billion feet, to which may be added about 9 billion feet of small timber which was not included in the estimate of the saw-material on the coast. This, at 700 b.f. per cord, amounts to 255 million cords of pulpwood available in the province.

The Dominion Government controls the forest resources in the Railway Belt and the Peace River Block, the forests in the remainder of the province

* Prof. K. W. Woodward places the growth of the Douglas fir type in a rotation of 100 years at 90,000 b.f. per acre, an average of 900 b.f. per acre per annum. (*Journal of Forestry*, Vol. XV., No. 5, p. 530.)

† Includes all classes of timber of commercial size.

being under Provincial jurisdiction. The following is a summary of the forest resources under Dominion and Provincial control :

	Land area	Area of forest land	Area of timber-land	Amount of timber
	Sq. miles	Sq. miles	Sq. miles	Million b.f.
Railway Belt	16,700	10,313	3,347	22,023
Peace River Block	5,470	3,779	1,142	4,545
Total Dominion lands	22,170	14,092	4,489	26,568
Total Provincial lands	331,341	135,252	47,522	339,732
Total	353,511	149,344	52,011	366,300

Though it has been possible to obtain a reasonably accurate estimate of the proportion of the forest resources which has been alienated on the coast, it was impossible to segregate the alienated and unalienated timber in the interior with any degree of certainty. It is estimated, however, that nearly 75 per cent of the timber of commercial value in the province has been alienated under one form or another. The following table shows the estimated amounts of each species which have been alienated or which still belong to the Crown :

ESTIMATED AMOUNT OF TIMBER ALIENATED AND UNALIENATED IN BRITISH COLUMBIA (million board feet)

	Coast (saw material)			Interior			Total		
	Alienated	Unalienated	Total	Alienated	Unalienated	Total	Alienated	Unalienated	Total
Western red cedar	55,726	4,223	59,949	16,000	2,019	18,019	71,726	6,242	77,968
Douglas fir	60,628	2,772	63,400	10,000	2,573	12,573	70,628	5,345	75,973
Spruce (all species)	12,742	1,423	14,165	11,700	47,199	58,899	24,442	48,622	73,064
Western hemlock	48,319	3,629	51,948	9,000	3,164	12,164	57,319	6,793	64,112
White fir (balsam)	17,885	1,230	19,115	2,000	11,838	13,838	19,885	13,068	32,953
Lodgepole pine	63	5	68	4,000	7,793	11,793	4,063	7,796	11,860
Western yellow pine	......	......	......	3,500	708	4,208	3,500	708	4,208
Yellow cypress	3,737	319	4,056	......	......	......	3,737	319	4,056
Western larch	......	......	......	2,300	852	3,152	2,300	852	3,152
Western white pine	1,044	39	1,083	1,300	317	1,617	2,344	356	2,700
Cottonwood	472	44	516	200	72	272	672	116	788
Total	200,616	13,684	214,300	60,000	76,535	136,535	260,616	90,218	350,834

The amount of timber alienated, under the various forms of tenure, is considered to be as follows :

	M.b.f.
Provincial timber licenses	161,300,000
Crown-granted or applied for	50,000,000
Provincial timber leases	22,000,000
Dominion timber licenses	17,400,000
Provincial pulp leases	9,600,000
Provincial timber sales	316,000
	260,616,000

CHAPTER II

Forest Resources of the Interior of British Columbia

IN discussing the forest resources of any region, the first essential is to arrive at some conclusion regarding the areas of the different classes of land, with reference to their capacity to produce timber. In this report, any area in the interior of British Columbia that is capable of producing saw-timber that will yield 1,000 b.f., or more, to the acre is considered merchantable timber-land, regardless of whether or not the area is considered commercially accessible under present market conditions. This conception assumes that conditions in the future might be such that areas now considered commercially inaccessible will become available if the price of stumpage rises. At the present time, it does not pay to extract timber lying at high altitudes, or remote from driveable streams or railway transportation, as the cost of marketing is prohibitive.

How much per acre an area must yield before it is considered merchantable timber is also a relative question. Easily accessible timber, containing 2,000 or 3,000 b.f. per acre, may be more valuable at the present time than less favourably situated timber containing 10,000 b.f. A considerable portion of the timber being cut in the interior of the province is taken from stands that will average under 5,000 b.f. per acre. In the Atlin district, saw-timber is being removed for local purposes from lands that will average less than 2,000, and, in some instances, less than 1,000 b.f. per acre. It is conceivable, from a long-time point of view, that, in many cases, conditions may be such that lands carrying 1,000 b.f. per acre would be considered a good logging chance, at least for local consumption. As a matter of fact, a very large percentage of the land that is capable of carrying timber at all can produce stands that will average over 5,000 b.f. per acre, and it is only on poor sites, covering very small areas, that the capacity to produce timber falls below 5,000 b.f. With these facts in mind, an attempt has been made to arrive at the area of the province capable of producing merchantable saw-timber.

In a mountainous region like British Columbia, a large percentage of the area lies at high altitudes. In the interior of the province, at the southern boundary (latitude 49°), saw-timber is usually not found above the 6,000-feet contour line. For the purpose of this report, this is called the 'merchantable timber-line.' Towards the north, this line becomes lower, until, at 60° latitude (the northern boundary of the province), it lies at approximately 3,000 feet altitude. The 'cold timber-line' is, as a rule, from 800 to 1,200 feet above the merchantable timber-line. The zone between these two—the sub-alpine zone—contains tree growth which usually does not reach saw-timber size. The forests of this zone are of value mainly for protecting the watershed.

An attempt has been made to indicate the boundaries of the area below the merchantable timber-line, as distinguished from the areas above, and, where topographic and reconnaissance maps are available, this attempt has been reasonably successful. However, out of the total area of the interior, comprising some 294,000 square miles, about one-third, or approximately 100,000 square miles, is not covered by even rough sketch-topographic maps. Nevertheless, a fairly successful attempt has been made to delimit the area above the merchantable timber-line from that below, for these unsurveyed areas, as well as for those which have been mapped more or less accurately. The table on page 245 shows the results of this part of the investigation.

For descriptive purposes, that portion of the province lying to the east of the axes of the Cascade and Coast mountains, known as the Interior, has been divided into six regions, which are further subdivided into forty drainage basins, as follows :*

Region South of the Railway Belt—
- Elk and Flathead
- Goat, Moyie and Yahk
- Upper Kootenay South
- Upper Columbia and Upper Kootenay North
- Lower Kootenay Lake
- Upper Kootenay Lake and Duncan River
- Lower Columbia and Salmo
- Lower Arrow Lake and Slocan River
- Upper Arrow Lake
- Kettle
- Shuswap
- Okanagan
- Nicola and Similkameen

Railway Belt, Interior—
- Golden Section
- Revelstoke Section
- Shuswap Lake Section
- Kamloops-Lytton Section

South Central Region—
- Big Bend of Columbia and Canoe River
- Adams and Seymour
- North Thompson
- Bonaparte, San Jose and Mahood
- Bridge and Chilcotin
- Nechako and Blackwater
- Quesnel River Section
- Willow and Bowron
- Upper Fraser

North Central Region—
- Parsnip
- Stuart, Salmon and Nation
- Upper Skeena
- Upper Nass
- Finlay

*See map showing position of drainage basins.

Base map from plate of Map of Dominion of Canada. Dept of Interior

Region East of Rocky Mountains—
- South Pine
- Peace River Block
- North Pine and Halfway
- Fort Nelson Section

Northern Region—
- Dease and Kachika
- Stikine and Unuk
- Taku
- Atlin
- Alsek and Chilkat

AREAS ABOVE AND BELOW MERCHANTABLE TIMBER-LINE, INTERIOR OF BRITISH COLUMBIA

Regions *	Total area, sq. miles	Above merchantable timber-line		Below merchantable timber-line	
		Area, sq. miles	Per cent of total	Area, sq. miles	Per cent of total
South of Railway Belt......	32,505	8,257	26	24,248	74
Railway Belt..............	12,845	3,062	24	9,783	76
South-Central.............	70,431	16,237	24	54,194	76
North-Central.............	58,428	25,313	43	33,115	57
East of Rocky Mountains...	59,276	14,665	25	44,611	75
Northern B.C..............	60,573	47,999	79	12,574	21
Total.................	294,058	115,533	39	178,525	61
Total, acres...........	188,197,120	73,941,120	..	114,256,000	..

This table shows that, of the 294,058 square miles of terrain in the interior of the province, 115,533 square miles, or 39 per cent, has too severe a climate to produce merchantable timber. It shows also that there is 178,525 square miles, or 61 per cent, which, so far as temperature conditions are concerned, can produce merchantable timber. For that portion of the interior lying within the Railway Belt and to the south of it, the merchantable timber-line is estimated to be at the 6,000-feet contour line; for the south-central region, from 5,000 to 6,000 feet; for the north-central region, from 4,000 to 5,000 feet; for the region east of the Rocky mountains, from 3,500 to 4,500 feet; and, for the northern interior of the province, from 1,500 to 3,500 feet. The minimum altitude of the timber-line in the latter-named region is due to the influence of the coastal climate along the rivers that break through the Coast mountains.

The high percentage of the terrain that lies above the commercial timber-line in northern and north-central British Columbia is due, not so much to altitudinal as to latitudinal effects on the climate. On the other hand, the region east of the Rocky mountains, though extending from latitude 54° to 60°, shows as low an average percentage of areas below merchantable timber-line as do the southern and south-central portions of the province west of the

* For areas included in above regions see Drainage Basins map.

Rockies. This is due to the fact that a great part of this region lies at a relatively lower altitude than does the adjoining portion west of the Rocky mountains.

While temperature conditions are favourable to forest growth on 178,525 square miles of terrain in the interior of British Columbia, a portion of this area is considered incapable of carrying timber, due, mainly, to soil and other conditions. In the first place, there is an area, situated mostly within the 'dry belt', where the moisture conditions are unfavorable to the production of merchantable timber. This region lies below what can be called the 'dry merchantable timber-line', and is mostly covered with grass, sagebrush or very open timber. Including the areas that formerly carried forests, but, owing to repeated fires, have a vegetative cover mainly of grass, sage brush or park forests, the known area of this class of land is 5,022 square miles, or 3,214,080 acres*

Again, a considerable portion of the area of the province is occupied by lakes. The mapped lake area (in the interior) alone covers 4,711 square miles, or 3,015,040 acres. Other classes of terrain that do not carry forest growth are: Areas occupied by swamps, rivers, rock outcrops, land slides, soils too shallow for timber growth, precipitous slopes, and areas that formerly carried forest growth but have been badly burned.† A rough estimate of the aggregate of such areas (exclusive of lakes) is 32,979 square miles, or 21,106,560 acres; including the lakes and grass land, 42,712 square miles.

The classification of the area in the interior of British Columbia below merchantable timber-line, divides it into two categories :

(1) land capable of carrying merchantable timber, and

(2) land incapable of so doing—is as follows :

CLASSIFICATION OF LANDS BELOW MERCHANTABLE TIMBER-LINE WITH RESPECT TO THEIR CAPACITY TO BEAR TIMBER—INTERIOR OF BRITISH COLUMBIA

Regions	Total area, sq. miles	Incapable of bearing saw-timber		Capable of bearing saw-timber	
		Area, sq. miles	Per cent of total	Area, sq. miles	Per cent of total
South of the Railway Belt...	24,248	3,501	14	20,747	86
Railway Belt..............	9,783	1,447	15	8,336	85
South-Central.............	54,194	5,660	14	48,534	86
North-Central.............	33,115	3,596	11	29,519	89
East of the Rocky Mts......	44,611	24,402	55	20,209	45
Northern B.C..............	12,574	4,106	33	8,468	67
Total.................	178,525	42,712	24	135,813	76
Total, acres...........	114,256,000	27,335,680	..	86,920,320	..

* This includes only the known areas of this class. In central and northern British Columbia and in the region north of the Peace River Block there are very large areas that formerly were forested, but which now carry grass.

* Some of these areas, like swamps, prairies due to fires, and badly burned areas, could, under intensive management, be forested, but for the purposes of this discussion they are not considered as forest lands.

This table shows that 135,813 square miles, or 86,920,320 acres, in the interior is capable of bearing merchantable timber. This represents about three-quarters of the area below merchantable timber-line, but it is only 46 per cent, or less than one-half, of the total area of the interior. Conversely, more than one-half of the interior, taken as a whole, is incapable of bearing merchantable timber. Of this, more than two-thirds is above merchantable timber-line, the remainder, representing 15 per cent of the total area of the interior, being below this line.

The reason why so large an area of the region east of the Rocky mountains—24,402 square miles, or more than one-half of the total—is incapable of bearing saw-timber, is discussed in the descriptions of the drainage basins of the Fort Nelson river and the Peace River Block (see pp. 307, 310).

The total area of land in the interior, 135,813 square miles, that is classed as being capable of carrying merchantable forest, would be considered as the area of 'absolute timber-land,' were it not for the fact that some of it may ultimately be more valuable for other than forest purposes. There is estimated to be 11,978 square miles of such land in the interior as a whole.* Deducting this amount, leaves 123,835 square miles, or 79,254,400 acres, as a rough estimate of the absolute forest land of the interior. This represents about 42 per cent of its entire area.

To consider this large area of timber-land with reference to the condition of its present stand, it has been divided into four classes. These are as follows :—(1) Areas in which the standing timber will average over 10,000 b.f. per acre; (2) areas in which the average is between 5,000 and 10,000 b.f.; (3) areas in which the average is below 5,000 b.f., and (4) areas that carry timber which has not yet reached merchantable size. This latter class includes those areas that carry all stages of reproduction, from one-year growth to pole size, and a rather large area which has been burned over recently, but has not had sufficient time to re-stock. It does not include the area so severely burned that it cannot recover without artificial planting.†

Thus, of the 135,813 square miles of land in the interior of British Columbia, that is capable of bearing merchantable timber, only 40,649 miles, or 30 per cent, is carrying merchantable timber at the present time. The remaining 70 per cent, or 95,164 square miles, may be taken as a rough estimate of the area that has been badly damaged by fire, and is re-stocking, or partially re-stocking, with forest growth of some kind.

From still another viewpoint, it appears that only one-seventh (13·8 per cent) of the total area of the interior of British Columbia is bearing merchantable timber.

* Including the 5,022 square miles of grass-land, the total area of agricultural land in the interior is estimated at 17,000 square miles.

† It was hoped, when the investigation was commenced, that it would be possible to arrive at some estimate of the areas of the different age-classes of reproduction, and to make some statement respecting the different conditions of re-stocking, that is, what proportion of the area is fully re-stocked, etc. The information available, however, is not sufficient to justify even rough estimates covering these important questions.

CLASSIFICATION OF FOREST LAND BY STAND TYPES—INTERIOR OF BRITISH COLUMBIA

Regions	Total area capable of bearing saw-timber	With timber averaging over 10 M. per acre		With timber averaging between 5 M. and 10 M. per acre		With timber averaging between 1 M. and 5 M. per acre		Areas carrying reproduction; no merchantable timber	
		Area	Per cent	Area	Per cent	Area	Per cent	Area	Per cent
	Sq. miles	Sq. miles		Sq. miles		Sq. miles		Sq. miles	
South of Railway Belt..........	20,747	678	3·3	2,476	11·9	5,014	24·2	12,579	60·6
Railway Belt....	8,336	497	6·0	775	9·3	1,570	18·8	5,494	65·9
South-Central....	48,534	990	2·1	4,707	9·6	7,561	15·6	35,276	72·7
North-Central....	29,519	296	1·0	4,261	14·4	7,080	24·0	17,882	60·6
East of Rocky Mts..........	20,209	259	1·2	1,539	7·6	1,563	7·8	16,848	83·1
Northern B.C....	8,468	28	·3	347	4·1	1,008	11·9	7,085	83·7
Totals......	135,813	2,748	2·0	14,105	10·4	23,796	17·5	95,164	70·1

It is roughly estimated that, of the area bearing merchantable timber, the stand has been materially reduced in quantity by the ravages of forest fires on about one-half, or some 20,000 square miles. This situation is clearly indicated by the fact, as shown in the table, that of 40,649 square miles bearing stands of timber averaging more than 1 M. feet per acre, only 2,748 square miles, or 6·8 per cent, contains stands averaging more than 10 M. per acre; 14,105 square miles, or 34·7 per cent, contains stands between 5 M. and 10 M. per acre; while 23,803 square miles, or 58·5 per cent, carries timber averaging between 1 M. and 5 M. per acre. These figures show in a striking manner the effect which forest fires have had in reducing the amount of timber in the interior of British Columbia.

ESTIMATE OF TIMBER IN THE INTERIOR OF BRITISH COLUMBIA
(In thousand feet, board measure)

Region	Stand of 10 M. or over per acre	Stand class between 5 M. and 10 M. per acre	Stand class between 1 M. and 5 M. per acre	Total
South of Railway Belt.......	6,360,600	10,798,800	8,803,480	25,962,880
Railway Belt...............	5,036,800	3,382,800	2,921,400	11,341,000
South-Central...............	10,824,760	22,469,800	12,718,800	46,013,360
North-Central...............	2,831,600	21,442,800	13,635,300	37,909,700
East of Rocky Mountains....	1,921,000	7,201,200	2,960,800	12,083,000
Northern B.C...............	268,800	1,665,600	1,290,400	3,224,800
Total.................	27,243,560	66,961,000	42,330,180	136,534,740

The foregoing table shows that there is approximately 136 billion board feet of timber in the interior of the province. Of this amount, it is roughly estimated, 60 billion board feet has been alienated from the Crown, leaving approximately 76 billion feet still under full government control. The amount

of timber alienated under the license system is estimated to be 42 billion board feet. The remaining 18 billion feet is on Crown-leased and Crown-granted lands. The large bodies of unalienated Crown timber are north of the Railway Belt, and at the present time are, to a large extent, commercially inaccessible.

ESTIMATED AMOUNT OF TIMBER BY SPECIES AND REGIONS—INTERIOR OF BRITISH COLUMBIA

(In thousand feet, board measure)

Species	South of Railway Belt	Railway Belt	South-Central	North-Central	East of Rocky Mts.	Northern B.C.	Total
Douglas fir	3,999,676	2,190,540	5,541,190	841,272	....	....	12,572,678
Western red cedar	4,391,748	2,179,080	10,121,304	1,327,292	....	....	18,019,424
Western hemlock	2,422,456	1,438,590	2,888,344	4,053,128	....	1,361,280	12,163,798
Balsam	1,300,264	472,280	4,206,442	7,195,936	331,260	332,000	13,838,182
Spruce	5,192,790	2,834,970	19,095,266	21,742,819	8,741,600	1,290,160	58,898,605
Western white pine	1,030,546	272,604	313,355	....	....	....	1,616,505
Western yellow pine	2,525,688	1,215,420	466,816	....	....	....	4,207,924
Lodgepole pine	1,953,744	731,696	3,379,643	2,647,849	2,932,300	148,240	11,793,472
Western larch	3,145,968	5,820	....	....	....	....	3,151,788
Cottonwood	....	....	....	101,404	77,840	93,120	272,364
Total	25,962,880	11,341,000	46,013,360	37,909,700	12,083,000	3,224,800	136,534,740

Approximately 59 billion feet, or nearly one-half of the stand of timber in the interior, is spruce; this, with the exception of about 3 billion feet, is Engelmann spruce. Next to spruce in amount is red cedar, with a stand of approximately 18 billion feet. This is concentrated in heavy stands along the streams that lie in the interior wet belt. The next species, in order of amount, is balsam fir, with nearly 14 billion feet. This lies mainly within the spruce type, usually above an altitude of 4,000 feet; in the northern portion, it is found at low altitudes, although in such places it constitutes a smaller proportion of the stand. Hemlock constitutes some 12 billion feet of the total. It usually accompanies the cedar in the interior wet belt, but is also found in portions of the Skeena, Nass, Unuk, Stikine and Taku basins. There is approximately 12½ billion feet of Douglas fir. This is found throughout most of the interior, from the 49th to the 55th parallel, either in a type by itself or as a constituent element in other types. Although lodgepole pine contributes large areas of young growth throughout the entire interior, investigation shows that there is only about 12 billion feet of this species of saw-timber size.

There is approximately 4 billion feet of yellow pine in the interior. This is confined mostly to the drier portions of the region in and south of the Railway Belt. Larch is next in importance, representing slightly over 3 billion feet of the stand. It is confined to the south-eastern part of the province, mainly south of the Railway Belt.

There is, approximately, 1·6 billion feet of western white pine. It is scattered throughout the cedar and Douglas fir-larch types in the wet belt. Most of it is found south of the Railway Belt, especially along the international boundary, just north of the state of Idaho, where it is especially abundant. As the cruisers usually do not consider it, it has been difficult to make even

a rough estimate of the amount of cottonwood. There is probably about one billion feet more of this species than is indicated in the table.

Description of Drainage Basins

REGION SOUTH OF THE RAILWAY BELT

Drainage Basins of Elk and Flathead Rivers

Position and Physical Features

The Elk and Flathead basins are situated in the heart of the west slope of the Rocky mountains, in the extreme south-eastern corner of the province. The axis of the Rocky mountains forms their eastern boundary, and a series of ranges separates them from a section of the Kootenay River drainage on the west, except where the Elk river breaks through this barrier and emerges into the Rocky Mountain trench.

This region, a narrow one, with a length of 110 miles and an average width of 20 miles, parallels the axis of the Rockies. With the exception of a short section that crosses the eastern half of the Rocky Mountain trench, it includes the entire drainage of Elk river, and also that portion of Flathead river lying within the province.

Elk river occupies a long U-shaped, glacial-scoured valley, whose bottom varies in altitude from 3,082 feet, where it emerges into the Rocky Mountain trench, to 5,000 feet, near its headwaters. It has three main tributaries—Wigwam river, Michel creek and Fording river. Throughout its course, the Elk and its tributary valleys are hemmed in by high mountains, except for their outlets and low passes at their headwaters.

Flathead river, like the Elk, has a U-shaped valley, and varies in altitude from 3,950 feet to approximately 5,000 feet at its headwaters. Except for passes which connect it with the tributaries of Wigwam river, on the west, and Michel creek, on the north, it also is bounded by high mountains.

The mountains surrounding these basins, and separating their component parts, vary in altitude from 6,500 to 8,000 feet, with a number of peaks rising to a height of between 8,000 and 10,000 feet above sea level.

Only meagre climatic data are available for the district. A one-year (1915) precipitation record shows that Elko (altitude 3,089 feet), at the mouth of Elk valley, has a total of about 26 inches, one-third of which was in the form of snow; during the year 1915, the precipitation at Fernie (altitude 3,313 feet), a short distance north of Elko, aggregated 38 inches, about one-half of which was in the form of snow. Crowsnest (altitude 4,451), on the eastern edge of the basin, had, during the same year, a total of about 12 inches, one-third of which was snow. As 1915 was an exceptionally wet year for the region, these figures are probably somewhat higher than the average for a number of years. Perhaps the major portions of the valleys of the Elk and the Flathead, which lie centrally located in the basins, will show an average precipitation of nearly 30 inches, with a decided decrease for the regions near the dry eastern slopes of the Rocky mountains. The precipitation is fairly well distributed throughout the year.

The mean annual temperature for Fernie (average of a number of years) is 39°, while that of Elko (one year's average) is nearly 44°. This illustrates the lower temperature conditions at a station situated well in the mountains, compared with one on the eastern edge of the Rocky Mountain trench and at a lower altitude. Exceptionally dry and hot summers occur periodically, however, and, at such times, destructive forest fires are likely to take place.

Forest Conditions

Forty-three per cent of the area is above merchantable timber-line, about the 6,000-foot contour; while 57 per cent is below this line. Of this latter amount, 112 square miles is considered incapable of producing merchantable timber, leaving 1,205 square miles that can be classed as timber-land.

CLASSIFICATION OF LANDS, WITH AMOUNT OF STANDING TIMBER, IN THE ELK-FLATHEAD DRAINAGE BASIN

Classes of land	Area, sq. miles	Percentage of entire area	Saw-timber, M.b.f.
Above merchantable timber-line	1,001	43	......
Below merchantable timber-line—			
Area carrying 10,000 b.f. or more per acre	29	1·2	278,400
Area carrying between 5,000 and 10,000 b.f. per acre	273	11·9	1,300,400
Area carrying between 1,000 and 5,000 b.f. per acre	420	18·1	806,400
Area carrying young growth	483	20·9	....
Area incapable of carrying timber	112	4·9	....
Total	2,318	....	2,385,200

Merchantable Timber by Species

The amount of merchantable timber, by species, in the Elk-Flathead drainage basin is as follows: Douglas fir, 53,272 M.b.f.; red cedar, 62,828 M.b.f.; balsam, 208,472 M.b.f.; spruce, 1,524,488 M.b.f.; lodgepole pine, 512,288 M.b.f.; larch, 23,852 M.b.f,; or a total of 2,385,200 M.b.f.

As might be expected, the main type of the basin is the Engelmann spruce. Indications are that, at one time, the Douglas fir-larch type occurred in the drier situations at the lower ends of the Elk and Wigwam valleys, but it has been mostly destroyed. The cedar-spruce type occupied the moist situations along the lower Elk, and remnants of it still occur in the side valleys of this portion of that basin.

Over large areas, due entirely to repeated fires, the lodgepole pine temporary type prevails. An area greatly damaged by repeated fires lies along the line of railway in the Elk valley and its tributary, the Michel valley. Fires in this valley have been historic, because they have involved, not only the destruction of forests, but of lives and towns. In regions more remote from the railway, the fires have not been so frequent.

Where the forest has been only slightly damaged by fire, the reproduction is mostly spruce, balsam and lodgepole pine, but the last-named species becomes more prominent with the increase in severity of previous fires. The area carrying timber under 5,000 feet per acre is either growing stock re-

covering from the effects of fires which occurred 50 to 75 years ago, or consists of damaged remnants of mature timber which escaped the effects of past fires.

Lumbering Operations

Situated near the prairie market, which borders it on the east, this district has long been active in lumbering. Logging operations have been carried on within easy reach of the Canadian Pacific railway and of a short railway that extends southward, along Michel creek, to Corbin. Considerable quantities of timber are still found in the valleys of the short streams that flank the west side of Elk valley and the north and west sides of Michel creek, but no timber remains in the portion of the main valley traversed by the Canadian Pacific.

Some logging operations have been carried on in Elk valley, north of the point where the railway enters it, but, up to the present, they have not been extensive. When required, the timber that lies well to the north end of this valley will be available.

The timber in the Flathead valley is mountain-locked. The only natural outlet is by driving it down the Flathead and across the boundary line into the United States. The development of the coal-fields in this valley will very possibly offer the best opportunity for the utilization of this timber. If these coal fields prove of sufficient value, the railway, which now ends at Corbin, will no doubt be extended across the pass at the head of Michel creek into the Flathead valley. Such a road would give an outlet for the timber. There are no insurmountable difficulties in the way of driving the main stream of both basins.

Other Industries

Besides lumbering, the main industry of the region is coal mining. Extensive coal-fields exist, but only those immediately along the railway are being developed.

Because of the high average altitude of the region, a great part of it is too cold for agricultural purposes. Patches of good soil are found in the lower half of Elk valley and are suitable for growing garden truck and forage crops. The timber grazing and open lands in the burned-over portions of the valley will, however, support a limited number of stock for perhaps seven months of the year. It is estimated that 34 square miles, or 1·5 per cent of the whole, comprises the area within which agriculture can be carried on. *

Drainage Basin of the Goat, Moyie and Yahk Rivers

Position and Physical Features

This area lies at the southern end of that portion of the Purcell section of the Selkirk mountains which is within the province. It comprises the whole of the Goat basin and the portions of the Yahk and Moyie basins lying to the north of the international boundary. These basins are separated from each other by low ranges of mountains.

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* The estimates of the agricultural area of this and the other drainage basins include the area within which the climatic conditions are such that agricultural pursuits of some kind can be carried on. Within these, there are large areas where soil conditions are unfavourable. With the data at hand it is not possible to give an estimate of their extent. (See Stand Type map for the situation of the so-called agricultural areas.)

The Yahk basin is the most easterly one. It is mountain-locked on all sides, its only natural outlet being southward into the United States. The lowest altitude of this basin is 3,100 feet. Low timbered passes connect it to the east with the Rocky Mountain trench and to the west with Moyie valley. The Moyie basin occupies the medial portion of the three basins and is separated from the Yahk basin by the Yahk range and from the Goat basin by the Moyie range. Its lowest altitude is 2,650 feet. The Goat basin lies well toward the Purcell trench, and, for most of its length, is separated from it by a range of mountains. The Goat river breaks through this barrier at its southern end, and empties into the Kootenay river, a short distance above the southern boundary of the province. Its lowest elevation is 1,760 feet. Generally speaking, the mountains of these basins reach a height of between 6,000 and 7,500 feet.

Creston (altitude 1,989 feet), situated near the mouth of Goat river, has an annual precipitation of 23 inches, about one-fourth of which is snow. This is distributed fairly well throughout the year. Judging from the vegetation in the valleys heading in the Moyie range, the precipitation is somewhat heavier, perhaps 35 inches, while in the Yahk range and Yahk valley it is probably between 20 and 25 inches.

Creston has an annual mean temperature of 44°, a summer mean of 63°, and a winter mean of 26°. The highest recorded temperature is 96° and the lowest is 12°. Compared with West Kootenay, the climate of this region is milder and more moist. With the exception of the Yahk basin, it is mostly within the limits of the Interior wet belt.

The merchantable timber-line lies at about 6,000 feet altitude. Of the total area of Yahk, Goat and Moyie basins, 19 per cent is above this line and 81 per cent is below. It is estimated that, of the 1,046 square miles below merchantable timber-line, 75 square miles is considered incapable of bearing timber.

CLASSIFICATION OF LANDS, WITH AMOUNT OF STANDING TIMBER, IN THE GOAT, MOYIE AND YAHK DRAINAGE BASIN

Classes of land	Area, sq. miles	Percentage of entire area	Saw-timber M.b.f.
Above merchantable timber-line	238	19	....
Below merchantable timber-line—			
Area carrying 10,000 b.f. or more per acre	55	4·2	528,000
Area carrying between 5,000 and 10,000 b.f. per acre	258	20·0	1,238,400
Area carrying between 1,000 and 5,000 b.f. per acre	146	11·3	277,400
Area carrying young growth	512	39·8	....
Area incapable of carrying timber	75	5·7	....
Total	1,284	....	2,043,800

Merchantable Timber, by Species

The amount of merchantable timber, by species, in the Goat-Moyie-Yahk drainage basin is as follows: Douglas fir, 122,628 M.b.f.; red cedar, 163,504 M.b.f.; hemlock, 81,752 M.b.f.; balsam, 81,752 M.b.f.; spruce, 674,454 M.b.f.; white pine, 204,380

M.b.f.; lodgepole pine, 163,504 M.b.f.; larch. 551.826 M.b.f., or a total of 2,043,800 M.b.f.

The principal species are thus spruce and larch. This is due to the fact that the Douglas fir-larch and the Engelmann spruce types cover most of the region. The former lies mainly below and the latter mainly above the 4,000-feet contour line. The moister sites along the streams carry the cedar-hemlock type, but their total area is not large. Where the region has been badly burned, the reproduction is mainly lodgepole pine, but, where fires have not been so destructive, the proportion of this species is much less ; on some reproducing areas it is entirely absent.

Lumbering Operations

Lumbering operations have been confined to the region along that portion of the Moyie and Goat rivers traversed by the Crowsnest line of the Canadian Pacific. The timber of the Yahk basin has a natural outlet down this river, and across the boundary into Idaho. What was the most accessible timber along the railway has been burned.

Other Industries

Mining has been long an active industry, especially around the Moyie lakes. There is an admirable farming region near the mouth of Goat river and in the Purcell trench, near Creston. At present, fruit is the principal crop raised, though the region is well adapted for mixed farming. Certain other sites along the railway may ultimately be used for farming purposes. It is estimated that 131 square miles, or 10 per cent of the whole, comprises the area within which agricultural pursuits may be carried on. Of this, 13 square miles is now covered with statutory timber.

Drainage Basin of Upper Kootenay South.

Position and Physical Features

This basin lies at the southern end of the Rocky Mountain trench. It comprises the area drained by that portion of the Kootenay river in the trench, and includes all its subsidiary streams, except the portion of Elk river already considered. Its eastern boundary is the summit of the ranges separating it from the Elk River drainage. Its western boundary is the summit of the Purcell mountains.

Strategically, the main physical feature of the region is the southern end of the Rocky Mountain trench. The medial part of this trench is about 17 miles wide, narrowing down to approximately 5 miles at the southern end and to about 4 miles at its northern end.

The altitude of the bottom of the valley at the international boundary is 2,371 feet ; at Canalflats, the northern end of the basin, it is 2,666 feet, giving a descent for the river of only 295 feet in about 90 miles of its course. Portions of the Kootenay river have a meandering course, with a wide flood plain, and consequently a sluggish current ; at other places, the river has a comparatively straight course and swift current. On the whole, it is admirably adapted for driving logs, while the many side channels afford good opportunities for booming them.

The main tributaries of this section of the Kootenay are the Elk, St. Mary and Bull rivers and Gold, Sheep and Skookumchuck creeks. Gold creek drains the eastern slopes of the McGillivray range of the Purcell mountains, which border the trench on the western side at its southern end. These mountains are comparatively low, only small sections of them extend above the merchantable timber-line. They separate the regions under discussion from the Yahk basin.

The Galton range of the Rocky mountains lies east of the southern section of the trench. The summits of these mountains are, for the most part, from 7,000 to 8,000 feet in altitude, lying well above merchantable timber-line. A small section of Elk river crosses the trench in a deep, narrow cañon, debouching into Kootenay river a short distance above the mouth of Gold creek. Bull river has a southerly course, and its valley separates the mass of high mountains lying between the trench and the Elk river into two ranges. The tributaries of the St. Mary river rise in the summits of the Purcell range. This river has a nearly straight easterly course, emptying into Kootenay river a short distance north of the mouth of Bull river. The most northerly tributaries are Skookumchuck creek, which drains the eastern slopes of the Purcell mountains, and Sheep creek, which drains the western slopes of the Rockies. The mountains on either side of this portion of the trench have an altitude of between 7,000 and 8,000 feet.

The average annual precipitation of the trench is between 16 and 20 inches, about one-third of which is snow. It is fairly well distributed throughout the year, but occasional very dry summers render the forest vegetation extremely inflammable. A higher precipitation occurs in the bordering tributaries; in those on the east, the annual rainfall will probably not exceed 25 inches. The upper half of St. Mary river lies well within the wet belt, and probably has a precipitation of not less than 35 inches.

The mean annual temperature of the main valley of the Upper Kootenay South is about 40°, with a winter mean of 20°, and a summer mean of 59°. The lowest recorded temperature is −37° and the highest 103°. The valley is comparatively free from summer frosts, but late spring and early

CLASSIFICATION OF LANDS, WITH AMOUNT OF STANDING TIMBER, IN THE UPPER KOOTENAY SOUTH DRAINAGE BASIN

Classes of land	Area, sq. miles	Percentage of entire area	Saw-timber, M.b.f.
Above merchantable timber-line	1,284	35	....
Below merchantable timber-line—			
Area carrying 10,000 or more b.f. per acre	43	1·2	367,000
Area carrying between 5,000 and 10,000 b.f. per acre	601	16·5	1,923,200
Area carrying between 1,000 and 5,000 b.f. per acre	520	14·2	988,000
Area carrying young growth	1,003	27·5	....
Area incapable of carrying timber	151	4·2	....
Area carrying grass or very open forest	52	1·4	....
Total	3,654	....	3,278,200

autumn frosts are likely to occur. The temperature conditions at higher altitudes are, of course, much lower.

Forest Conditions

Thirty-five per cent of the area is above merchantable timber-line, which here lies at about the 6,000-feet contour. Of the 2,370 square miles lying below merchantable timber-line, 203 square miles is considered incapable of carrying merchantable forest.

Merchantable Timber by Species

The amount of merchantable timber, by species, in the Upper Kootenay South drainage basin, is as follows: Douglas fir, 627,184 M.b.f.; red cedar, 170,992 M.b.f.; hemlock, 72,344 M.b.f.; balsam, 237,840 M.b.f.; spruce, 267,600 M.b.f.; white pine, 13,000 M.b.f.; yellow pine, 697,104 M.b.f.; lodgepole pine, 311,936 M.b.f.; larch, 880,200 M.b.f., making a total of 3,278,200 M.b.f.

Yellow pine and Douglas fir-larch forest types are the most important, and are the types in which most of the logging operations are carried on. The yellow pine type occurs in strips, on the lower benches along the Kootenay, and some distance up the St. Mary, with isolated patches on exposed sites in other parts of the region. As a type, it is not found at altitudes much above 3,000 feet, but is often found scattered throughout the Douglas fir-larch type, and may form as much as 25 per cent of its stand.

The Douglas fir-larch type flanks the yellow pine type on the higher benches and lower slopes of the main valley, and extends back along the side streams to an altitude of approximately 2,500 feet, and, in exposed situations, to 4,000 feet. In the moister climate of the medial reaches of the St. Mary river, however, this type is replaced by the cedar-spruce type. Between 4,000 and 6,000 feet altitude, the spruce type prevails. The lodgepole pine temporary type has made inroads on all these types, as the result of fires, and occupies the largest area of any of them at present.

Above 6,000 feet is the subalpine type. The species found in this type are the same as those which occur in the drainage basins of the Elk and Flathead rivers.

Lumbering Operations

This drainage basin has long furnished the bulk of the timber manufactured in the interior of the province, and it still has sufficient quantities left to maintain this lead. It is well supplied with railway transportation facilities.

Nearly all the main tributaries are driveable, or can be made so with some improvement. Logging railways can be profitably constructed to some of the bodies of timber that are not favourably situated as regards driveable streams.

Agriculture on Logged-over Lands

Only one group of mines is being worked at present, in the Purcell mountains. This is located at Kimberley, at the terminus of a branch of the Canadian Pacific railway.

The agricultural areas of the region are confined to the trench proper. Nearly all of the land that is not at present held under timber licenses or leases has been alienated for agricultural or speculative purposes, mostly the latter. Logged-over timber licenses are usually pre-empted quickly, if not

situated at too high altitudes. The area, as a whole, is best adapted to cattle raising. The small areas of natural grass lands, including those made so by logging and fires, cannot by any means be considered first-class grazing lands, although they will support stock. There are large timbered areas that can be utilized for this purpose, but the great difficulty is that winter grazing cannot be depended on, because the snow is usually too deep. The amount of stock which can be supported economically depends, necessarily, on the quantity of winter forage crops raised.

Part of the area is too dry to be utilized for agriculture, without irrigation. The best soils are found in the bottoms, along the Kootenay river, though, even here, the area is limited in extent, as most of it is subject to overflow during floods. Fruit can be raised on irrigated lands, but, generally speaking, the climate is too cold to make this industry commercially profitable. Much of the land alienated for agricultural purposes is better suited for producing forest crops and for timber-grazing, and, probably, most of it will be thus utilized. It is estimated that 713 square miles, or nearly 20 per cent of the whole, comprises the area within which agricultural pursuits will be carried on. Of this, 52 square miles is in grass or very open lands, and 169 square miles is covered with statutory timber.*

Drainage Basins of the Upper Columbia and Upper Kootenay North

Position and Physical Features

These drainage basins lie north of the Upper Kootenay South and Elk River drainage basins, and south of the Railway Belt. The axis of the Columbia River drainage is that portion of the Rocky Mountain trench drained by the upper reaches of the Columbia. The axis of the Upper Kootenay North basin is the southern portion of what is known as the Kootenay-Beaverfoot trench, a secondary one, which joins the Rocky Mountain trench near the source of the Columbia river. These two trenches are separated by the Stanford and Brisco ranges, which reach an altitude of 6,000 to 8,000 feet.

The bottom of the Upper Kootenay valley varies in altitude, from 2,666 feet, where it connects with the Rocky Mountain trench, to 4,158 feet at the source of the Kootenay, 7 miles northwest of the southern boundary of the Railway Belt. It is flanked on the west by the Stanford and Brisco ranges, and on the east by the Mitchell and Vermilion ranges, which are of from 7,000 to 10,000 feet elevation. The mountains are divided into a number of ranges by the White, Palliser, Cross and Vermilion rivers, which, in general, flow in a southeasterly or southwesterly direction for some part of their courses. The streams that drain the east slopes of the Stanford and Brisco ranges are mountain brooks. The valleys of the Kootenay and its main tributaries are U-shaped and are flanked with a series of benches.

The bottom of the Rocky Mountain trench varies in altitude from 2,683 feet, at the headwaters of the Columbia river, to about 2,350 feet, at the southern boundary of the Railway Belt. This portion of the Columbia river

* See footnote, page 252.

contains two comparatively large lakes near its source, and below these the river follows a meandering course, with a rather wide area of swampy land, which is flooded during spring freshets. The Purcell mountains flank the trench on the west. The west slope of these mountains is drained by a number of small streams.

The Upper Columbia valley is the driest portion of the Rocky Mountain trench. Wilmer, on Windermere lake, has an annual precipitation of about 14 inches, a little less than one-third of which is snow. About one-third of the total is summer rainfall. The precipitation in the higher altitudes is evidently somewhat greater judging from the character of the vegetation, probably from 20 to 25 inches.

The mean annual temperature for the warmest part of the Columbia valley is about 39°, with a winter mean of 18°, and a summer mean of 60°. The highest recorded temperature is about 100° and the lowest −36°. The Kootenay valley and the higher altitudes have undoubtedly a lower mean temperature.

Forest Conditions

Fifty per cent of the area is above merchantable timber-line. Of the 2,073 square miles below this line, 301 square miles is open lands, including the grass area and lands incapable of carrying timber. The area has been badly burned, but is, for the most part, reproducing, mainly with lodgepole pine and spruce. All ages of reproduction are found ; on most of the area it is less than 30 years old.

CLASSIFICATION OF LANDS, WITH AMOUNT OF STANDING TIMBER, IN THE UPPER COLUMBIA-UPPER KOOTENAY DRAINAGE BASINS

Classes of land	Area, sq. miles	Percentage of entire area	Saw-timber, M.b.f.
Above merchantable timber-line	2,050	49·7	....
Below merchantable timber-line—			
Area carrying 10,000 b.f. or more per acre	3	0·1	14,400
Area carrying between 5,000 and 10,000 b.f. per acre	259	6·3	1,243,200
Area carrying between 1,000 and 5,000 b.f. per acre	520	12·6	998,400
Area carrying young growth	990	24·0	....
Area incapable of carrying timber	242	5·9	....
Area carrying grass or very open forest	59	1·4	....
Total	4,123	....	2,256,000

Merchantable Timber by Species

The amount of merchantable timber, by species, in the Upper Columbia-Upper Kootenay North drainage basins, is as follows: Douglas fir, 410,640 M.b.f.; balsam, 76,944 M.b.f.; spruce, 772,320 M.b.f.; yellow pine, 124,320 M.b.f.; lodgepole pine, 386,736 M.b.f.; larch, 485,040 M.b.f.; making a total of 2,256,000 M.b.f. There are, also, very small amounts of cedar and white pine.

The main forest types are the Douglas fir, the Douglas fir-larch and the Engelmann spruce types. The Douglas fir type is found mainly in the Columbia valley, reaching an altitude of 3,500 feet. The Douglas fir-larch type occupies the valleys of Kootenay river and Finlay creek, up to an altitude of 3,500 feet. The Engelmann spruce type occurs above 3,500 feet, and large areas of it have

been replaced by young growth of the temporary lodgepole pine type. At the southern end of the basin is a small area covered by the yellow pine type.

Above the 6,000-feet contour line lies the subalpine type, including varying mixtures of Engelmann spruce, alpine fir, alpine larch and white-bark pine.

Lumbering Operations

Logging operations have been confined to the Upper Columbia and its tributary valleys, on the east slopes of the Purcell mountains. Most of the logs have been driven to the town of Golden, and sawn there. Some of the side streams have been logged to near their head waters. There is very little statutory timber left in the Columbia basin.

The major portion of the easily accessible timber is found in the Kootenay valley, from Cross river south, and up the White River valley. None of this timber has been logged.

Within a few years, as the more accessible timber in the main Kootenay valley further south is cut, logging operations will probably be transferred to the upper Kootenay valley, with the manufacturing centre at Golden, or transferred to some point on the Kootenay Central branch of the Canadian Pacific, near Canalflats. The Kootenay river is a driveable stream, and its main tributaries can be made driveable. Practically all the statutory timber is accessible when market conditions are normal.

Other Industries

Practically all the land in the Columbia and Kootenay valleys, up to an altitude of 3,500 feet, and, in some cases, to 4,000 feet, has been alienated for agricultural purposes. It is doubtful, however, whether much of it will be used for farming for a long time to come. In localities where soil conditions are favourable, mixed farming is carried on, and, on specially warm sites where irrigation is possible, fruit raising has been fairly successful. As a whole, however, the great bulk of the land alienated for agricultural purposes can be used only for timber-grazing, with small patches here and there utilized for growing fodder crops for winter feeding.

It is estimated that 509 square miles, or 12 per cent of the whole, comprises the area within which agricultural pursuits will be carried on. Of this, 59 square miles is in grass or in 'park' forests, and 69 square miles is covered with merchantable forest.*

Lower Kootenay Lake Drainage Basin

Position and Physical Features

The centre of this drainage basin is the southern one-third of that portion of the Purcell trench that lies within the province. The bottom of this trench is here occupied by Kootenay lake. The level of the lake is about 1,760 feet above the sea. It is flanked, on the east, by the Purcell mountains, and on the west, by ranges of the Selkirk mountains. Usually the precipitous slopes of these mountains rise from the level of the lake to a height of from 7,000 to 9,000 feet. Since the axes of the

* See footnote on p. 252.

flanking mountain ranges are fairly close to the lake, the streams that drain their slopes are short, and none of them is dignified with the name of 'river.'

The precipitation of the region, for stations on the lake, is between 17 and 28 inches, about one-fourth to one-third of which is snow. Two stations, a short distance from the lake, show a precipitation of nearly 35 inches. It is thus apparent that the record of the side valleys is greater than that of the main valley.

The meteorological stations show an annual mean temperature of 45°, with a winter mean of 28°, and a summer mean of 61°. The highest recorded temperature is 100° and the lowest −17°. These stations are, at the lowest altitudes, near the level of the lake. The climatic conditions of the higher altitudes are naturally more severe.

Forest Conditions

Thirty per cent of the area of this drainage basin is above merchantable timber-line. Of the area below this line, 224 square miles is incapable of growing timber. Further details are set forth below.

CLASSIFICATION OF LANDS, WITH AMOUNT OF STANDING TIMBER, IN THE LOWER KOOTENAY LAKE DRAINAGE BASIN

Classes of land	Area, sq. miles	Percentage of entire area	Saw-timber, M.b.f.
Above merchantable timber-line	460	30·0	....
Below merchantable timber-line—			
Area carrying 10,000 b.f. or more per acre	87	5·6	696,000
Area carrying between 5,000 and 10,000 b.f. per acre	45	2·8	216,000
Area carrying between 1,000 and 5,000 b.f. per acre	110	7·0	220,000
Area carrying young growth	624	40·2	....
Area incapable of carrying timber	224	14·4	....
Total	1,550	....	1,132,000

Merchantable Timber by Species

The amount of merchantable timber, by species, in the Lower Kootenay Lake drainage basin, is as follows: Douglas fir, 156,800 M.b.f.; red cedar, 319,600 M.b.f.; hemlock, 171,800 M.b.f.; balsam, 37,600 M.b.f.; spruce, 119,600 M.b.f.; white pine, 204,400 M.b.f.; yellow pine, 11,000 M.b.f.; larch, 111,200 M.b.f.; making a total of 1,132,000 M.b.f.

The Douglas fir-larch, the cedar-hemlock and the Engelmann spruce are the principal forest types of the region. The first two lie below the 3,500-feet contour line and the last between the 3,500-feet and the 6,000-feet contours. All three types have been badly damaged by fire. The cedar-hemlock type has suffered less from fire than the other types, because it lies along the streams, well back from the lake, and is accordingly favoured by moister soil conditions. On special sites along the lake there are small areas of the yellow pine type. The proportionately large amount of white pine in this region should be noted. Some sections, in both the cedar-hemlock and the Douglas fir-larch types, carry a relatively large proportion of this species; in some instances, as high

as 35 to 50 per cent of the stands is reported to be white pine. These areas are, however, so small that it has not been considered practicable to distinguish them as separate types.

As a whole, the region is reproducing fairly well with the species that formed the original forest. Some areas contain, however, a fairly large percentage of lodgepole pine reproduction. Near the international boundary, white pine is more than holding its own, and, here, the next forest will have a larger percentage of this species than does the present one.

Lumbering Operations

The logging operations of this basin have been mainly confined to the patches lying along or near the lake, which have escaped destruction by fire. The main bulk of the timber, however, lies along the small streams, well back from the lake. Some of these streams present difficulties in driving, and probably railways will have to be built before such timber can be marketed. Under present conditions, the timber on some of the streams is considered commercially inaccessible.

Other Industries

The very small patches of arable land lying along the lake are mainly utilized for growing fruit. It is estimated that 118 square miles is the area within which agricultural pursuits will be confined. This represents 7·6 per cent of the total area of the basin. None of it carries statutory timber, and most of it has been alienated from the Crown.

The mining industry is the principal one at the present time.

Upper Kootenay Lake and Duncan River Drainage Basins

Position and Physical Features

The centre of these drainage basins is the middle third of the Purcell trench. The most important side valley of this region is that occupied by the Lardeau river and Trout lake, known as the Lardeau-Trout Lake trench.

The side valleys of this portion of the Purcell trench, like those of the adjoining southern portion, are small mountainous streams, which enter the master valley through narrow cañons, behind which their valleys broaden out and carry considerable quantities of timber.

The mountains flanking the trenches and minor valleys on either side rise to a height of 7,000 to 10,000 feet, and a considerable portion of the area above 8,000 feet contains glaciers. The bottoms of the trenches vary in altitude from 1,760 feet, at Kootenay lake, to near 4,500 feet, at the headwaters of Duncan river. Trout lake has an altitude of 2,347 feet.

Only meagre climatic data exist for the region. Howser, near the head of Kootenay lake, has an annual mean temperature of 44°, with a winter mean of 26°, and a summer mean of 63°. The highest recorded temperature is 99° and the lowest −13°. These figures for Howser represent the warmest portion of the basins, and those for higher altitudes will show that the climate is more severe. At Ferguson (altitude 2,600), a one-year record shows that the precipitation is 40 inches, while Kaslo, on Kootenay lake, has a record of

26 inches, about one-third of which is snow. The above figures show that the basins lie well within the wet belt, the lower altitudes being drier than those above.

Forest Conditions

Of the total area, 47 per cent is above the merchantable timber-line, leaving 53 per cent below. Of this amount, all but 164 square miles, or 7·4 per cent, is capable of bearing timber. While forest fires have badly damaged the timber, they have not yet been sufficiently severe to render any considerable area incapable of recovering, or to bring about the replacement of the original forest with lodgepole pine reproduction, except as to small areas along Kootenay lake.

CLASSIFICATION OF LANDS, WITH AMOUNT OF STANDING TIMBER, IN THE UPPER KOOTENAY LAKE AND DUNCAN RIVER DRAINAGE BASINS

Classes of land	Area, sq. miles	Percentage of entire area	Saw-timber, M.b.f.
Above merchantable timber-line	1,042	47·0	....
Below merchantable timber-line—			
Area carrying 10,000 b.f. or more per acre	66	3·0	633,600
Area carrying between 5,000 and 10,000 b.f. per acre	274	12·3	1,315,200
Area carrying between 1,000 and 5,000 b.f. per acre	322	14·5	644,000
Area carrying young growth	350	15·8	....
Area incapable of carrying timber	164	7·4	....
Total	2,218	....	2,592,800

Merchantable Timber by Species

The amount of merchantable timber, by species, in the Upper Kootenay Lake and Duncan River drainage basins, is as follows: Douglas fir, 454,680 M.b.f.; red cedar, 842,560 M.b.f.; hemlock, 549,720 M.b.f.; balsam, 130,160 M.b.f.; spruce, 356,400 M.b.f.; white pine, 129,640 M.b.f.; larch, 129,640 M.b.f.; or a total of 2,592,800 M.b.f.

Cedar-hemlock, Douglas fir-larch, and Engelmann spruce are the principal types of the region. The cedar-hemlock type occupies the bottoms of the valleys of the moister situations up to an altitude of from 3,000 to 3,500 feet. In the drier parts, the Douglas fir-larch type is present up to this altitude. Above 3,500 feet, the Engelmann spruce type generally prevails. On the flood plains of Duncan river small areas of the cottonwood sub-type are found.

Lumbering Operations

The lumbering operations have been mainly confined to the lower end of Duncan river and along the Lardeau-Trout Lake trench. A combined railway and water transportation route connects the head of Trout lake with Kootenay lake. This latter lake is tapped at its southern end by the Crowsnest line of the Canadian Pacific railway. The heavy timber in the upper part of Duncan river is accessible from the head of Kootenay lake, where it can be milled and carried to points on the railway at the south end of the lake.

Other Industries

Mining is a prominent industry of the region. The mineral resources have for the most part not been developed, though

mining claims are located throughout the region. Ferguson, near the head of Trout lake, has, in the past, been the principal centre.

Small areas of agricultural land are found along Kootenay lake and a short distance up the main valleys. At the lowest altitudes, fruit raising is, or will be, the principal industry. At altitudes above 2,000 feet, however, the climate is too severe for this industry. Mixed farming will perhaps prosper on the small areas lying along the Lardeau-Trout Lake trench and the Duncan river between altitudes of 2,000 and 2,500 feet. It is estimated that 105 square miles, 4·7 per cent of the whole, comprises the area within which agricultural pursuits will be confined. Thirty-two square miles of this carries statutory timber.

Lower Columbia River and Salmo River Drainage Basins

Position and Physical Features

This region is tributary to the lower end of the Selkirk trench. It lies south of Lower Arrow lake and the western portion of the Nelson trench and extends to the international boundary.

The Nelson range of the Selkirk mountains forms the eastern boundary. These mountains have an altitude of between 6,000 and 7,000 feet. The Rossland range of the Monashee mountains lies to the west. Only a small area of these mountains is above 6,000 feet.

The bottom of the Columbia valley varies in altitude from 1,344 feet at the international boundary to 1,382 feet, the low-water level of Lower Arrow lake. The Columbia valley is separated from the Salmo valley by the Bonnington range, a small area of which is above the 6,000-foot contour. The Salmo valley, including a small section of the Pend d'Oreille river, varies in altitude from 1,344 feet to 3,083 feet.

Like that of the other basins, the climate of these varies according to the altitude. Nelson, with an altitude of 1,774 feet, has a mean annual temperature of 46°, with a winter mean of 28°, and a summer mean of 60°; the highest recorded temperature is 100° and the lowest −17°. Rossland, with an altitude of 3,500 feet, has a mean annual temperature of 42°, with a winter mean of 25°, and a summer mean of 60° ; the highest recorded temperature is 91° and the lowest −17°. The mean annual precipitation of Nelson is 28 inches, about one-third of which is snow, while the record for Rossland is nearly 30 inches, nearly one-half of which is snow. The valley of the Columbia evidently has a lower precipitation, and, in places, will probably fall below 20 inches. On the other hand, in the upper half of the valley of the Salmo, the precipitation will probably average well over 30 inches.

Forest Conditions

Ten per cent of the area is above merchantable timber-line, and 90 per cent below. Of the 1,150 square miles below the merchantable timber-line, 90 square miles is a rough estimate of the amount that is incapable of carrying merchantable timber. More than half of the area has been badly burned, but is mostly re-stocking with some kind of growth, except where fires have occurred recently.

CLASSIFICATION OF LANDS, WITH AMOUNT OF STANDING TIMBER, IN THE LOWER COLUMBIA AND SALMO DRAINAGE BASINS

Classes of land	Area, sq. miles	Percentage of entire area	Saw-timber, M.b.f.
Above merchantable timber-line	122	10·0	....
Below merchantable timber-line—			
Area carrying 10,000 b.f. or more per acre	57	4·4	547,200
Area carrying between 5,000 and 10,000 b.f. per acre	111	8·7	532,800
Area carrying between 1,000 and 5,000 b.f. per acre	320	25·1	409,600
Area carrying young growth	572	44·8	....
Area incapable of carrying timber	90	7·0	....
Total	1,272	....	1,489,600

Merchantable Timber by Species

The amount of merchantable timber, by species, in the Lower Columbia and Salmo drainage basins is as follows: Douglas fir, 189,200 M.b.f.; red cedar, 515,360 M.b.f.; hemlock, 263,840 M.b.f.; balsam, 20,480 M.b.f.; spruce, 162,560 M.b.f.; white pine, 128,480 M.b.f.; yellow pine, 20,480 M.b.f.; lodgepole pine, 40,960 M.b.f.; larch, 148,240 M.b.f.; total, 1,489,600 M.b.f.

Cedar-hemlock, Douglas fir-larch, and Engelmann spruce are the principal forest types. The latter usually occurs above 4,000 feet altitude. The yellow pine type occupies small areas along the Columbia river, but has been mostly logged. The Douglas fir-larch type usually occupies altitudes between 2,500 and 4,000 feet. In some places, however, it is found below 2,000 feet; such cases occur where moisture conditions are slightly more favourable than those required for the yellow pine type.

Lumbering Operations

Logging operations are, for the most part, limited to the main valleys of the region. The mills are situated at strategic points along the railways. The Canadian Pacific railway traverses nearly the entire length of the Columbia valley, below Lower Arrow lake, and the Great Northern traverses the upper half of the Salmo valley. From the town of Salmo, the Great Northern traverses a side valley to the Columbia. The easily accessible timber is almost gone, but side valleys contain considerable quantities that can be logged at slightly higher costs.

Mining and Fruit Growing

Mining is the principal industry of the region. Small areas of agricultural land lie along both the Salmo and Columbia valleys. Fruit raising is the chief farming industry. Because of the mountainous nature of the region, its extension is limited. There is a limited amount of land suitable for timber grazing, but so far it has been utilized but little. It is estimated that 212 square miles comprises the area within which agricultural pursuits will be confined. This represents 16·6 per cent of the total area. Thirty-one square miles of this carries statutory timber.

Lower Arrow Lake and Slocan River Drainage Basins

Position and Physical Features

That part of the Selkirk trench occupied by Lower Arrow lake, and the entire Slocan secondary trench, comprise the axes of these basins. They are separated from each other by the Valhalla range of the Selkirk mountains. This range is a high, rugged one, attaining an altitude that varies from 6,000 to well over 8,000 feet.

The basins are bounded on the east by the southern half of the Slocan range of the Selkirks. This range has an average altitude of over 7,000 feet ; some peaks reach between 9,000 and 10,000 feet. The western boundary is formed by the Christina range of the Monashee mountains, a small portion of which lies above the 6,000-feet contour line. The lowest altitude of the Selkirk trench is 1,382 feet, the level of Lower Arrow lake. The average altitude of the Slocan trench is about 1,800 feet.

The region is, for the most part, situated within the drier portions of the interior wet belt. The mean annual temperature for the lower altitudes is 44°, with a winter mean of 27°, and a summer mean of 44°. These figures, of course, represent the highest mean temperatures within the region. The precipitation of the region will vary from about 15 inches to nearly 30 inches, and perhaps to 35 inches, in the valleys back from the trench. The area of less than 20 inches precipitation is very small and lies along the shores of Lower Arrow lake, extending a short distance up Slocan river.

Forest Conditions

Twenty-five per cent of the area is above merchantable timber-line, and 2,156 square miles, or 75 per cent, is below. Of the latter, 248 square miles is considered incapable of bearing merchantable timber. The region has been badly burned over, especially that portion of it tributary to Lower Arrow lake and around Slocan lake. The burned areas are, as a rule, re-stocking with a growth that contains the species of the original forest. Small areas, however, are being re-stocked with lodgepole pine.

CLASSIFICATION OF LANDS, WITH AMOUNT OF STANDING TIMBER, IN THE LOWER ARROW LAKE AND SLOCAN RIVER DRAINAGE BASINS

Classes of land	Area, sq. miles	Percentage of entire area	Saw-timber, M.b.f.
Above merchantable timber-line	708	25	....
Below merchantable timber-line—			
Area carrying 10,000 b.f. or more per acre	102	3·5	652,800
Area carrying between 5,000 and 10,000 b.f. per acre	178	6·2	854,400
Area carrying between 1,000 and 5,000 b.f. per acre	450	15·6	576,000
Area carrying young growth	1,178	41·1	....
Area incapable of carrying timber	248	8·6	....
Total	2,864	....	2,083,200

Merchantable Timber by Species

The amount of merchantable timber, by species, in the Lower Arrow Lake and Slocan River drainage basins, is as follows : Douglas fir, 345,120 M.b.f.; red cedar, 532,320 M.b.f.; hemlock, 287,520 M.b.f.; balsam, 106,848 M.b.f.; spruce, 356,160 M.b.f.; white pine,

97,632 M.b.f.; yellow pine, 71,520 M.b.f.; lodgepole pine, 100,320 M.b.f.; larch, 185,760 M.b.f.; or a total of 2,083,200 M.b.f.

Cedar-hemlock, Engelmann spruce, Douglas fir-larch and yellow pine are the principal forest types of the region. Engelmann spruce usually occurs above the 4,000-feet contour. The cedar-hemlock type is found in the moister portions of the region, below 4,000 feet altitude, along the mountain streams. The yellow pine type is found in the driest portions, usually below 2,500 feet altitude. The Douglas fir-larch type is present in that portion of the region below the 4,000-feet contour, where the rainfall does not exceed 26 inches.

Lumbering Operations

Logging operations have been confined to the easily accessible timber tributary to Lower Arrow lake, to the combined rail and water transportation that traverses the entire length of the Slocan trench, and to its tributary streams, especially Little Slocan river. The mills are found at strategic points on Lower Arrow lake, principally at the southern end, and on the Slocan river.

Other Industries

Mining is the principal industry of the region, the main centre being situated on the railway that connects Slocan lake with Kootenay lake.

Narrow patches of land along the trenches, and in some instances extending up the side valleys, are suitable for agricultural purposes. Fruit raising is the principal agricultural industry. The valleys of Inonoaklin (Fire valley) and Whatshan creeks contain considerable areas of land that can be utilized for mixed farming purposes. It is estimated that 258 square miles, or 9 per cent of the entire basin, comprises the area within which agricultural development will be confined. Of this area, 32 square miles is covered with statutory timber.

Upper Arrow Lake Drainage Basin

Position and Physical Features

The axis of this drainage basin is situated in that portion of the Selkirk trench occupied by Upper Arrow lake. It lies just south of the southern boundary of the Railway Belt. The region is bounded on the east by the upper half of the Lardeau range of the Selkirk mountains, and on the west by a section of the Monashee mountains. The Lardeau range is, for the most part, high and rugged, with peaks that extend well over 8,000 feet. The section of the Monashee mountains that forms the western boundary, especially the northern part, contains peaks of an altitude well over 9,000 feet. There are a number of fairly prominent tributary valleys. On the east side are the Kuskanax, St. Leon and Halfway creeks ; on the west are Arrowpark, Vanstone and Pingston creeks. The streams contain fairly wide U-shaped valleys, and carry most of the standing timber. The Trout Lake-Lardeau trench, which connects the Selkirk and the Purcell trenches, opens into the northern end of Upper Arrow lake. The lowest elevation of the basin is 1,383 feet, which is the low-water level of Upper Arrow lake.

Nakusp, situated near the lower end of the lake, has a mean annual temperature of 43°, with a winter mean of 27°, and a summer mean of 60°. The

highest recorded temperature is 95° and the lowest −5°. This station probably represents the warmest section of the basin. The precipitation of the basin is probably between 25 and 40 inches. The former figure holds for the portion of the area at low altitudes along the lake, while the tributary valleys will show a precipitation between 25 and 40 inches, the latter amount occurring at the higher altitudes.

Forest Conditions

Twenty-nine per cent of the area is above the merchantable timber-line, and 71 per cent, or 832 square miles, below. Of this area, 164 square miles is considered incapable of bearing merchantable timber. Although the region has been damaged by forest fires, it is recovering from this damage by good reproduction, mostly of the species that formed the original forest.

CLASSIFICATION OF LANDS, WITH AMOUNT OF MERCHANTABLE TIMBER, IN THE UPPER ARROW LAKE DRAINAGE BASIN

Classes of land	Area, sq. miles	Percentage of entire area	Saw-timber, M.b.f.
Above merchantable timber-line	337	29	....
Below merchantable timber-line—			
Area carrying 10,000 b.f. or more per acre	118	10·1	1,132,800
Area carrying between 5,000 and 10,000 b.f. per acre	106	9·0	508,800
Area carrying between 1,000 and 5,000 b.f. per acre	204	17·4	391,680
Area carrying young growth	240	20·5	....
Area incapable of carrying timber	164	14·0	....
Total	1,169	....	2,033,280

Merchantable Timber by Species

The amount of merchantable timber, by species, is as follows : Douglas fir, 248,352 M.b.f.; red cedar, 830,784 M.b.f.; hemlock, 443,712 M.b.f.; balsam, 101,664 M.b.f.; spruce, 287,520 M.b.f.; white pine, 78,566 M.b.f.; lodgepole pine, 19,584 M.b.f.; larch, 23,098 M.b.f.; or a total of 2,033,280 M.b.f.

Cedar-hemlock is the principal forest type of the region. It occupies the moister portions of the tributary valleys, up to an altitude of 4,000 feet. A thin zone of the Douglas fir-larch type is found along the Upper Arrow lake, especially the lower half. Above these types, between altitudes of 4,000 and 6,000 feet, is the Engelmann spruce type.

Industrial Operations

The logging operations of the basin have been confined mostly to the accessible timber along the lake. The mills are at or near Nakusp and at the head of Arrow lake.

The mining resources of the basin have been little developed.

Small areas of agricultural land are found along the lake, especially near the southern end, where fruit growing is the principal industry. Portions of the valleys of Vanstone and Arrowpark creeks contain agricultural land that will be suitable for mixed farming. It is estimated that 119 square miles, or 10·1 per cent of the basin, comprises the area within which agricultural de-

velopment will be confined. Of this area, 40 square miles carries statutory timber.

Kettle River Drainage Basin

Position and Physical Features

This basin extends from the international boundary, through one degree of latitude, to the 50th parallel. It is bounded on the east by the axis of the Monashee mountains, and on the west by the axis of the divide that separates it from the Okanagan trench. It thus drains a portion of the western slope of the Monashee mountains and part of the extreme eastern portion of the southern Fraser plateau.

The main Kettle river flows in a southerly direction, through about the middle of the drainage basin, approximately dividing the Fraser plateau and the Monashee mountains, until it reaches a point near the international boundary, where it makes an abrupt turn east and almost parallels the boundary, until it leaves British Columbia altogether near the southern end of Christina lake.

Granby (North fork of Kettle) river rises in the axis of the Columbia mountains, and flows directly south, joining the main river near the international boundary. It separates two ranges of the Monashee mountains, namely, the Christina range, on the east, and the Midway mountains, on the west. The drainage basin of the west branch of the Kettle, the Westkettle river, is entirely within the Fraser plateau. The Kettle river and its main tributaries have U-shaped valleys.

Only small portions of the area lie above the 6,000-feet contour, the lowest altitude of the basin being about 1,460 feet.

The mean annual temperature of the portion of the Kettle valley near the international boundary is 44°, with a winter mean of 24°, and a summer mean of 62°. The highest recorded temperature is 104° and the lowest is −42°. These figures do not represent the averages for the upper portions of the valley nor for the higher altitudes.

The precipitation in the valleys near the boundary is about 15 inches, but meagre data and the character of the vegetation show that this very dry condition does not exist in the upper portions of the valleys nor at the higher altitudes. Thus, a one-year reading for Carmi (altitude 2,792 feet), on the Westkettle, shows a precipitation of 24 inches, and Lynch creek (altitude 1,900 feet), on Granby river, has an annual precipitation of nearly 23 inches.

Forest Conditions

Twelve per cent of the area is above merchantable timber-line, and 2,716 square miles, or 88 per cent, is below. Of the latter, 92 square miles carries grass or very open timber, and 162 square miles is considered incapable of carrying merchantable timber, leaving 2,462 square miles that is timber-land. The region has been very badly burned, and over large areas the original forest has been replaced by lodgepole pine, or by this species mixed with Douglas fir, larch or Engelmann spruce.

CLASSIFICATION OF LANDS, WITH AMOUNT OF STANDING TIMBER, IN THE KETTLE RIVER DRAINAGE BASIN

Classes of land	Area, sq. miles	Percentage of entire area	Saw-timber, M.b.f.
Above merchantable timber-line	359	12	....
Below merchantable timber-line—			
Area carrying 10,000 b.f. or more per acre	....	....	....
Area carrying between 5,000 and 10,000 b.f. per acre	109	3·5	408,800
Area carrying between 1,000 and 5,000 b.f. per acre	810	26·1	1,296,000
Area carrying young growth	1,543	50·2	....
Area incapable of carrying timber	162	5·2	....
Area carrying grass or very open forest	92	3·0	....
Total	3,075	....	1,704,800

The amount of merchantable timber by species in the Kettle River drainage basin is as follows : Douglas fir, 402,280 M.b.f.; red cedar, 20,440 M.b.f.; hemlock, 4,088 M.b.f.; balsam, 129,600 M.b.f.; spruce, 287,816 M.b.f.; white pine, 8,176 M.b.f.; yellow pine, 150,040 M.b.f.; lodgepole pine, 300,080 M.b.f.; larch, 402,280 M.b.f.; or a total of 1,704,800 M.b.f.

Yellow pine, Douglas fir-larch and Engelmann spruce are the principal forest types of the region. The former occupies the lower altitudes at the southern end of the valley and forms islands in the Douglas fir-larch type, on southern exposures, up to altitudes of 3,000 feet. The Douglas fir-larch type occurs at altitudes between 2,500 and 4,000 feet, above which lies the Engelmann spruce type. On moist sites, especially in the valleys of the western slope of the Monashee mountains, there are small areas of the cedar-hemlock type. Large areas of the temporary lodgepole pine type have replaced the original types.

Lumbering Operations

Logging operations are mostly confined to the Granby valley and around Christina lake. The mills are situated at favourable points on the Boundary branch of the Canadian Pacific railway, which traverses that basin from east to west, along and near the boundary line. A railway extends some distance up the Granby river and a branch of the Great Northern connects the region with the main line in the United States. The Kettle Valley railway traverses a portion of the main Kettle river and of the Westkettle and crosses the divide to Okanagan lake and thence to the Coast. These railways afford outlet for the small amount of timber that is manufactured.

Other Industries

Where irrigation is possible, the climate near the boundary line is favourable for fruit raising. Agricultural areas best suited for mixed farming extend some distance up the main valleys. The rough, open areas and timbered lands adjoining them afford good grazing. It is estimated that the area of arable land aggregates 370 square miles, or 12 per cent of the area of the basin. Of this, 12 square miles bears statutory timber.

The chief industry of the region is mining. The main mining centres are at Grand Forks, Greenwood, Phœnix, and on the Granby river.

Shuswap River Drainage Basin

Position and Physical Features

This basin comprises that portion of the Shuswap River drainage lying south of the Railway Belt. The river rises in the Railway Belt, flows south through Sugar lake, turns abruptly west for a short distance, then north through Mabel lake. The outlet of this lake is wholly within the Railway Belt. It flows west to the Okanagan trench, and then north, along this trench, to Mara lake, an arm of Shuswap lake. The portion of the river under discussion, and its numerous tributaries, for the most part lie within the west slope of the Monashee mountains. The southern branches drain a small section of the Fraser plateau.

This section of the Monashee mountains rises to an altitude of well over 7,000 feet, with some peaks along the axis of the mountains of 9,000 feet or more. The lowest altitude of the basin is 1,270 feet, the level of Mabel lake. The valley of the Shuswap river and its main tributaries have the usual U-shaped form in cross-section, the slopes of which rise abruptly into the flanking mountain ranges that border them.

Only very meagre climatic data are available for the region. The nearest station for the moister portions of the region is Griffin lake (altitude 1,511 feet), lying north in the Railway Belt. Incomplete records for this station show a precipitation of 34 inches, about two-fifths of which is snow. A one-year record for Richlands (altitude 1,400 feet), lying in a wide valley near the southern part of the basin, shows a precipitation of 24 inches. The moister portions of the region have a precipitation of between 25 and 35 inches. Towards the east, however, this probably drops to about 20 inches. The warmest parts of the basin probably have a mean annual temperature of about 42°.

Forest Conditions

Sixteen per cent of the area is above the line of merchantable timber, and 1,163 square miles, or 84 per cent, lies below. Of the latter, 121 square miles is considered as incapable of bearing timber, leaving 1,042 square miles as the area utilizable for producing merchantable timber.

CLASSIFICATION OF LANDS, WITH AMOUNT OF STANDING TIMBER, IN THE SHUSWAP RIVER DRAINAGE BASIN

Classes of land	Area, sq. miles	Percentage of entire area	Saw-timber, M.b.f.
Above merchantable timber-line	224	16	....
Below merchantable timber-line—			
Area carrying 10,000 b.f. or more per acre	118	8·5	1,510,400
Area carrying between 5,000 and 10,000 b.f. per acre	72	5·2	345,600
Area carrying between 1,000 and 5,000 b.f. per acre	300	21·5	600,000
Area carrying young growth	552	40·5	....
Area incapable of carrying timber	114	8·2	....
Area carrying grass or very open forest	7	0·1	....
Total	1,387	....	2,456,000

While fires have badly damaged the timber of the Shuswap basin, much of it is reproducing fairly well, mostly with species of the original growth.

Some areas have been entirely captured by the lodgepole pine temporary type, especially in the driest portions of the region.

Merchantable Timber by Species

The amount of merchantable timber, by species, in the Shuswap River drainage basin, is as follows: Douglas fir, 280,160 M.b.f.; red cedar, 933,360 M.b.f.; hemlock, 547,680 M.b.f.; balsam, 117,856 M.b.f.; spruce, 201,152 M.b.f.; white pine, 166,272 M.b.f.; yellow pine, 18,912 M.b.f.; lodgepole pine, 80,736 M.b.f.; larch, 109,872 M.b.f.; or a total of 2,456,000 M.b.f.

Cedar-hemlock, Engelmann spruce, and Douglas fir-larch are the principal forest types. Small areas of yellow pine occur on exposed sites in the drier portions of the region. Engelmann spruce occurs between the 4,000 and 6,000-feet contour lines; the cedar-hemlock type is found below this altitude in the wet valleys, and the Douglas fir-larch type in the drier portions of the valleys.

Lumbering Operations

Logging operations have been confined to the timber adjacent to the main river below Sugar lake, principally around Mabel lake. This timber is driven down the Shuswap river and milled at Enderby, on the Okanagan branch of the Canadian Pacific railway.

The timber lying above Mabel lake is accessible in the same manner. Short railways may be necessary, however, to enable the smaller streams to be logged. A projected railway, connecting Vernon with points on the Shuswap river between Mabel and Sugar lakes, would, if built, render the timber on the Shuswap more accessible by saving the long drive.

Farming

Favourable localities along the Shuswap and its tributary are suitable for mixed farming purposes. The principal farming at the present time is raising forage crops, mostly hay. Favourable warm sites are suitable for growing fruit, but, for the most part, the climate is too severe for this industry. It is estimated that 146 square miles, or 10·5 per cent of the basin, comprises the area within which agricultural pursuits will be carried on. Of this, 3 square miles carries statutory timber.

Okanagan Drainage Basin

Position and Physical Features

This basin extends from the international boundary to the southern boundary of the Railway Belt. The Okanagan trench is the main axis of the basin. Okanagan, Dog and Osoyoos lakes occupy most of the area of the bottom of the trench. Short sections of the Okanagan river connect the lakes with each other. The trench has a broad U-shaped form, and rises abruptly to the uplands of the plateau which flank the trench on either side. The bottom of the trench has an altitude varying from 913 to 1,125 feet, the latter figure being the level of Okanagan lake. The streams that border the trench on either side are short, but have U-shaped valleys. The uplands have an average altitude of about 4,500 feet, with some portions above the 6,000-feet contour.

The annual mean temperature of four stations on or near the lake is 46°, with a winter mean of 26°, and a summer mean of 64°. The highest recorded

temperature is 104°, and the lowest −22°. The temperature of the adjoining uplands is much cooler.

The stations on Okanagan lake show an average precipitation of about 12 inches, one-third of which is in the form of snow. A short record for Fairview, in a side valley near the boundary line, shows a precipitation of 9 inches. A one-year record for two stations at the heads of the side valleys, at an elevation of approximately 4,000 feet, shows a precipitation of about 20 inches. This indicates that the moisture conditions of the uplands are much more favourable for forest growth than are those of the main valley. The vegetation along the lake is grass or very open forests. (See Stand Type map.) South of the lake, where the rainfall is below 10 inches, the vegetation approximates arid conditions, and sagebrush is a conspicuous element in the vegetative cover.

Forest Conditions

This basin, situated in the Fraser plateau, has but two per cent of its area above merchantable timber-line. Of the 2,825 square miles situated below this line, 774 square miles consists of areas of water, grass or very open timber, and land incapable of bearing timber, leaving 2,051 square miles suitable for growing timber. On the area given as carrying a stand of less than 5,000 feet per acre. there are many small patches that would run about 5,000 feet per acre, but it has not been feasible to segregate these.

The basin has been badly burned, especially on the uplands. These areas are re-stocking with lodgepole pine or with this species mixed with Engelmann spruce, Douglas fir, and, in places, larch.

CLASSIFICATION OF LANDS, WITH AMOUNT OF STANDING TIMBER, IN THE OKANAGAN DRAINAGE BASIN

Classes of land	Area, sq. miles	Percentage of entire area	Saw-timber, M.b.f.
Above merchantable timber-line	71	2·4	....
Below merchantable timber-line —			
Area carrying 10,000 b.f. or more per acre	....	....	....
Area carrying between 5,000 and 10,000 b.f. per acre	22	0·8	105,600
Area carrying between 1,000 and 5,000 b.f. per acre	422	14·6	844,000
Area carrying young growth	1,607	55·4	....
Area incapable of carrying timber	250	8·7	....
Area carrying grass or very open forest	524	18·1	....
Total	2,896	....	949,600

In the Okanagan drainage basin, the amount of merchantable timber, by species, is as follows : Douglas fir, 284,880 M.b.f.; balsam, 28,488 M.b.f.; spruce, 113,952 M.b.f.; yellow pine, 427,320 M.b.f.; larch, 94,960 M.b.f.; total, 949,600 M.b.f.

Yellow pine, Douglas fir, Douglas fir-larch and Engelmann spruce are the principal forest types. The yellow pine type usually occupies the region below the 2,500-ft. contour line. On exposed southern slopes it will extend up to 3,000 feet. Islands of this type occur also in the areas shown on the map as open or semi-open lands. Douglas fir is usually found above the 2,500-ft. contour

line, but, on northern slopes, it may be found at lower, and, on southern exposures, at higher altitudes. It reaches to the limits of the Engelmann spruce type, and gradually merges into it. The Engelmann spruce type usually occupies the region above 4,000 feet, though tongues of it may be found along streams at lower altitudes. The Douglas fir-larch type occupies small areas, especially on the the east side of the basin, and at altitudes between 2,000 and 4,000 feet. The temporary lodgepole pine type covers large areas, but the cruises do not indicate that lodgepole pine has reached merchantable size.

Lumbering Operations

A number of small mills are found in the basin. The logs are obtained from the small patches of timber usually situated at some distance from the lake. Most of the timber is commercially inaccessible at the present time.

An Agricultural District

The basin is primarily an agricultural one. Owing to the dry climate, however, irrigation is necessary, and conservation of the water supply of the uplands depends upon preservation of the forest cover. Fruit raising is the principal industry, though stock-raising is also important. The open and semi-open lands of the major and minor valleys afford good grazing land. Cereals can be grown, and, at one time, considerable wheat was produced. The areas suitable for agriculture have practically all been taken up, either for cultivation or for grazing purposes. It is estimated that 671 square miles, or 23·2 per cent of the whole, is agricultural land. Of this, 13 square miles carries statutory timber, while 524 square miles is too dry for this purpose. Except where cultivated, this area is in grass or very open forest.

Nicola River and Similkameen River Drainage Basins

Position and Physical Features

These basins lie between the Okanagan basin, on the east, and the Railway Belt, on the west, and extend from the international boundary, on the south, to the Railway Belt, on the north. The Nicola basin occupies the northern section and the Similkameen the southern section of the area. The greater portion of the area lies within the southern part of the Fraser plateau. At the south, however, the continuity of the plateau is broken by spurs of the Cascade mountains. The main Similkameen river rises just south of the 49th parallel and flows north, draining the area between a portion of the Okanagan range on the east and the Hozameen range on the west. At Princeton, it is joined by the Tulameen river, which rises in the Railway Belt, and has a general easterly course. From Princeton, the course of the Similkameen is south-eastward to its confluence with the Okanagan river, just south of the international boundary.

Nicola river rises in the Fraser plateau opposite the western tributaries of Okanagan lake. It has a general westerly course, until it crosses the boundary of the Railway Belt, where it makes an abrupt northwest turn, and maintains this course until it joins the Thompson river. Its main tributary, the Coldwater, rises in the Railway Belt, near the headwaters of the Coquihalla, and has a general northerly course, joining the Nicola at Merritt. All the main valleys have the usual U-shaped form in cross section.

The uplands of the plateau have a general elevation of about 3,500 feet, with small portions on the Okanagan border rising to about 6,000 feet. The ranges of the Cascade mountains, near the 49th parallel, are high and rugged, some peaks reaching an altitude of over 8,000 feet, with a fairly high percentage of the mountains above 6,000 feet. Within the region under discussion, the lowest altitude of the Similkameen valley is 1,170 feet, and of the Nicola valley, 1,825 feet.

The climatic conditions of the basins vary according to the altitude. A station at Nicola lake (altitude 2,056 feet) has a mean annual temperature of 42°, with a winter mean of 24°, and a summer mean of 60°. This station has an annual precipitation of 11 inches.

The following shows the temperature conditions of points in the Similkameen valley, and includes one station in the Okanagan range :

Station	Altitude, feet	Annual mean	Summer mean	Winter mean	Annual precipitation, inches
Princeton	2,112	42°	61°	20°	13
Hedley	1,771	45°	64°	25°	11
Keremeos	1,372	47°	68°	26°	8
Hedley Mines	4,500	38°	52°	20°	26

These stations show a higher precipitation and lower temperature conditions for the higher altitudes.

Forest Conditions

Eight per cent of these drainage basins lie above the line of merchantable timber. Such areas are found mostly in the Cascade mountains, near the international boundary. Of the 4,332 square miles, or 92 per cent, of the area below this line, 3,563 square miles is considered capable of carrying merchantable timber. A large portion of this area has been badly burned, but is reforesting, mostly with lodgepole pine.

CLASSIFICATION OF LANDS, WITH AMOUNT OF STANDING TIMBER, IN THE NICOLA-SIMILKAMEEN DRAINAGE BASINS

Classes of land	Area, sq. miles	Percentage of entire area	Saw-timber, M.b.f.
Above merchantable timber-line	361	8	....
Below merchantable timber-line—			
Area carrying 10,000 b.f. or more per acre	....	....	....
Area carrying between 5,000 and 10,000 b.f. per acre	168	3·5	806,400
Area carrying between 1,000 and 5,000 b.f. per acre	470	9·9	752,000
Area carrying young growth	2,925	62·3	....
Area incapable of carrying timber	190	4·0	....
Area carrying grass or very open forest	581	12·3	....
Total	4,695	....	1,558,400

Merchantable Timber by Species

The amount of merchantable timber, by species, in these drainage basins is as follows : Douglas fir, 424,480 M.b.f.; balsam, 22,560 M.b.f.; spruce, 68,768 M.b.f.; yellow pine, 1,004,992 M.b.f.; lodgepole pine, 37,600 M.b.f.; total, 1,558,400 M.b.f.

Yellow pine, Douglas fir and Engelmann spruce are the principal types. The two last named have been replaced over large areas by the temporary lodgepole pine type. The yellow pine type is found usually below altitudes of 2,500 feet, though, on exposed southern slopes, it occurs up to 3,000 feet. The Douglas fir type lies between these altitudes and about 4,000 feet, above which the Engelmann spruce type usually prevails.

Lumbering and Other Industries

The largest mill in the dry belt drawing its supplies entirely from this belt, is found in this region. This, and a number of smaller mills, obtain their supplies from the easily accessible timber lying along the railway that traverses the Similkameen, Coldwater and Nicola rivers.

Stock-raising is the principal industry of the region. The large areas of open and semi-open lands, together with a large percentage of the timber-land, afford good grazing. In the warmer portions of the valleys, where the mean annual temperature is above 42°, fruit-raising is a successful industry. Dry farming has also proved successful on special sites. For raising fruit and other crops, irrigation is necessary to secure the best results. It is estimated that 827 square miles, or 17·6 per cent of the whole, comprises the area within which agricultural pursuits, including stock-raising, will be confined. Of this, 36 square miles carries statutory timber, and 584 square miles is in grass or very open forest growth.

Coal-mining is the chief industry around the town of Merritt, and, in the Similkameen basin, valuable minerals are found. The principal productive mining centre is at Hedley.

RAILWAY BELT—INTERIOR

Golden Section

Position and Physical Features

This region comprises the area draining into the portion of the Rocky Mountain trench that lies within the Railway Belt. It is bounded on the east by the axis of the Rocky mountains and on the west by the axis of the Selkirks. It thus includes, besides the Rocky Mountain trench, the portion of the Purcell trench drained by the Beaver river, which debouches into the Columbia river and enters the Rocky Mountain trench midway between the north and south boundaries of the Railway Belt.

The principal stream of the western slopes of the Rocky mountains is the Kicking Horse river. This river has a general southwest trend, to its junction with the Beaverfoot river, then turns abruptly to the north-northwest, and empties into the Columbia at Golden. Several tributaries enter this river, the largest being the Beaverfoot, whose valley, together with the upper Kootenay valley, form the Beaverfoot-Kootenay trench. The Beaverfoot valley is separated from the Columbia valley by the Beaverfoot range.

North of the Kicking Horse river, a section of the west slope of the Rockies is drained by the Blaeberry river, which has a general southwest trend. The Spillimacheen river drains a section of the Selkirk mountains. Its valley, like

the others, has a typical U-shaped form, parallels the general trend of the Columbia river, and is separated from that river by a low range of mountains.

The portion of the Purcell trench within the Railway Belt is drained by the Beaver river. Both the Selkirk and Rocky mountains contain high, rugged peaks, some of which reach an altitude of over 10,000 feet. The higher portions of these mountains contain numerous large glaciers. The Dogtooth range of the Selkirks, while not so high, nevertheless has a considerable portion of its area above the 6,000-feet contour. The lowest altitudes of the region are found in the bottom of the Rocky Mountain trench. At Golden station the altitude is 2,583 feet, and where the Columbia river crosses the northern boundary of the Railway Belt the altitude is about 2,300 feet.

The average of two stations (Golden and Donald) shows that this portion of the Rocky Mountain trench has a mean annual temperature of about 39°, with a mean winter temperature of 15°, and a summer mean of 59°. The highest recorded temperature is 97°, and the lowest −51°. The climate of the side valleys is much more severe than the lower altitudes of the Rocky Mountain trench, though there are no specific records. In the trench, north of Donald, the precipitation is still greater, but, to the east, as the summit of the Rocky mountains is approached, there is a gradual reduction in precipitation.

Forest Conditions

Fifty per cent of the area is above the merchantable timber-line. Of the 1,581 square miles below this line, 224 square miles is considered incapable of growing merchantable timber. Over large areas, lodgepole pine has replaced the original growth of spruce, balsam and other species.

CLASSIFICATION OF LANDS, WITH AMOUNT OF STANDING TIMBER, IN THE GOLDEN SECTION OF THE RAILWAY BELT

Classes of land	Area, sq. miles	Percentage of entire area	Saw-timber, M.b.f.
Above merchantable timber-line	1,594	50	....
Below merchantable timber-line—			
Area carrying 10,000 b.f. or more per acre	68	2·1	652,800
Area carrying between 5,000 and 10,000 b.f. per acre	126	4·0	604,800
Area carrying between 1,000 and 5,000 b.f. per acre	420	13·3	806,400
Area carrying young growth	741	23·4	....
Area incapable of carrying timber	226	7·2	....
Area carrying grass or very open forest	....	....	....
Total	3,175	....	2,064,000

Merchantable Timber by Species

In the Golden section of the Railway Belt, the amount of merchantable timber, by species, is as follows: Douglas fir, 206,400 M.b.f.; red cedar, 61,920 M.b.f.; balsam, 227,040 M.b.f.; spruce, 1,238,400 M.b.f.; white pine, 20,640 M.b.f.; lodgepole pine, 309,600 M.b.f.; total, 2,064,000 M.b.f.

Engelmann spruce, Douglas fir and cedar-spruce, and the temporary lodgepole pine, are the principal types. Of these, the Engelmann spruce formerly covered the largest portions of the region. Where it has not been destroyed by fire, this condition still prevails. The temporary lodgepole pine

type, except where established after severe burns, has a good mixture of spruce, which indicates that this species is in the ascendancy again.

Lumbering and Agriculture

Golden has long been a prominent saw-milling centre. Smaller mills are found in the Columbia and Kicking Horse valleys. On favourable sites in the Columbia valley there are patches of land suitable for agricultural purposes. The climate is too severe for fruit-raising on a commercial scale, although small fruits do well. Owing to climatic conditions, however, these lands will ultimately be used for dairying and cattle-raising. A limited amount of the timbered area can be used for grazing purposes. A portion of the Columbia river has a tortuous course with flood plains, and is subject to frequent overflows, Forage crops may be grown on the higher and drier portions of these flood plains. It is estimated that 124 square miles, or 3·9 per cent of the whole, comprises the area susceptible of agricultural development.

Railway Belt—Revelstoke Section

Position and Physical Features

The axis of this drainage basin is that portion of the Selkirk trench that traverses the Railway Belt. The basin lies between the summits of the Selkirk and Monashee mountains. The flanking mountains are of high altitudes, having peaks that reach from 9,000 to over 10,000 feet. A portion of their areas is covered with glaciers. The lowest altitude of the trench is 1,384 feet, at the southern boundary of the Railway Belt. At the northern boundary line it is about 1,650 feet. The principal tributary valleys are those occupied by the Incomappleux, Illecillewaet and Jordan rivers. These are typical U-shaped mountain valleys, whose heads are occupied by glaciers.

Revelstoke (altitude 1,497 feet) has a mean annual temperature of 43°, with a winter mean of 23°, and a summer mean of 61°. Its highest recorded temperature is 100° and the lowest −25°. Glacier (altitude 4,091 feet), situated not far from the tongue of a large glacier, has a mean annual temperature of 36°, with a winter mean of 23°, and a summer mean of 54°. The highest recorded temperature is 89° and the lowest −32°. The temperature conditions of these two stations represent nearly the extremes for the entire region.

The annual precipitation of Revelstoke is 42 inches, about one-third of which is in the form of snow ; that of Glacier is 57 inches, nearly three-fourths of which is in the form of snow. These two adjacent stations show strikingly the effect of difference in altitude on both moisture and temperature conditions. Glacier shows a higher precipitation than that recorded at any other station east of the Coast range.

Forest Conditions

Forty-nine per cent of the area lies above the merchantable timber-line. Of the 819 square miles lying below the line, 120 square miles is considered incapable of growing merchantable timber, leaving 699 square miles for the area of timber-land. The timber along the railway has been badly damaged by fire, but the climatic conditions are such that much of it can recover its former forest growth.

CLASSIFICATION OF LANDS, WITH AMOUNT OF STANDING TIMBER, IN THE REVELSTOKE SECTION OF THE RAILWAY BELT

Classes of land	Area, sq. miles	Percentage of entire area	Saw-timber, M.b.f.
Above merchantable timber-line	801	49	....
Below merchantable timber-line—			
Area carrying 10,000 b.f. or more per acre	105	6·5	1,344,000
Area carrying between 5,000 and 10,000 b.f. per acre	90	5·6	450,000
Area carrying between 1,000 and 5,000 b.f. per acre	150	9·4	285,000
Area carrying young growth	354	22·0	....
Area incapable of carrying timber	120	7·5	....
Total	1,620	....	2,079,000

Species of Merchantable Timber

The amount of merchantable timber, by species, in the Revelstoke section of the Railway Belt, is as follows : Douglas fir, 135,000 M.b.f.; red cedar, 864,000 M.b.f.; hemlock, 468,750 M.b.f.; balsam, 100,380 M.b.f.; spruce, 346,650 M.b.f.; white pine, 135,720 M.b.f.; lodgepole pine, 28,500 M.b.f.; total, 2,079,000 M.b.f.

Cedar-hemlock, cedar-spruce and Engelmann spruce are the forest types of the region. The latter type is usually found above the 4,500-feet contour. The cedar-spruce type lies between the 3,500 and 4,500-feet contours, and the cedar-hemlock below the 3,500-feet contour.

Lumbering and Other Operations

Revelstoke is a milling centre. There are also mills at points on the Canadian Pacific railway, where it traverses the Illecillewaet valley, and at Arrowhead, at the head of Arrow lake, just south of the Railway Belt. From a milling point of view, Arrowhead is the most important centre.

The mineral resources of the basin are undeveloped as yet. Small areas of agricultural land lie along the Columbia river. The climate of the region is just on the verge of being favourable for fruit-raising on a commercial scale. Dairy-farming is likely to be the chief agricultural industry, though the area suitable for farming is too small to permit any great development. It is estimated that 45 square miles, or 2·8 per cent of the whole, comprises the area within which agricultural developments will be carried on.

Railway Belt—Shuswap Lake Section

Position and Physical Features

This region includes that portion of the Railway Belt which drains into Shuswap lake. It comprises the drainage of the west slope of the Monashee mountains and small areas lying in the indefinite region between these mountains and the Fraser plateau.

The lower and upper reaches of the Shuswap river lie within the Railway Belt, the middle reach being south of it. The only other large stream within the region is the Eagle river. This rises in the Monashee mountains and flows west and southwest, debouching into Shuswap lake.

Some peaks in the axis of the Monashee mountains reach high altitudes, and a considerable portion of the area of the region is above the 6,000-feet contour. The lowest altitudes are those found in the bottoms of the main valleys, which range from a minimum of 1,140 feet up to 4,000 feet.

The climatic conditions are variable. Stations along the border of the dry belt, like Enderby and Salmon Arm, have a mean annual temperature of 45°, with a winter mean of 25°, and a summer mean of 64°. These stations have an annual precipitation of about 20 inches. Griffin lake, in the Eagle valley, has, on the other hand, a precipitation of 34 inches, indicating that the figure for the higher portions of the valleys, and for the higher altitudes generally, is between 30 and 40 inches.

Forest Conditions

Eleven per cent of the area is above merchantable timber-line. Of the 2,151 square miles below, 243 square miles is incapable of bearing timber, leaving 1,908 square miles as the estimated timber-land. While the region has been badly burned, it is, for the most part, recovering its original growth, except where repeated fires have reduced the soil factors to a condition that now favours the reproduction of lodgepole pine.

CLASSIFICATION OF LANDS, WITH AMOUNT OF STANDING TIMBER, IN THE SHUSWAP LAKE SECTION OF THE RAILWAY BELT

Classes of land	Area, sq. miles	Percentage of entire area	Saw-timber, M.b.f.
Above merchantable timber-line	252	11	....
Below merchantable timber-line—			
Area carrying 10,000 b.f. or more per acre	280	11·2	2,688,000
Area carrying between 5,000 and 10,000 b.f. per acre	189	7·8	907,200
Area carrying between 1,000 and 5,000 b.f. per acre	350	14·6	582,000
Area carrying young growth	1,089	45·3	....
Area incapable of carrying timber	243	10·1	....
Total	2,403	....	4,177,200

Merchantable Timber by Species

The amount of merchantable timber, by species, in the Shuswap Lake section of the Railway Belt is as follows : Douglas fir, 986,100 M.b.f.; red cedar, 1,253,160 M.b.f.; hemlock, 969,840 M.b.f.; balsam, 74,460 M.b.f.; spruce, 709,440 M.b.f.; white pine, 116,244 M.b.f.; yellow pine, 5,820 M.b.f.; lodgepole pine, 56,316 M.b.f.; larch, 5,820 M.b.f.; or a total of 4,177,200 M.b.f.

Cedar-hemlock, Engelmann spruce and Douglas fir-larch are the principal forest types. The larch in the Douglas fir-larch type is mostly in the form of young growth. Small islands of the yellow pine type occur on the borders of the dry belt. Engelmann spruce occupies the area above the 4,000-feet contour. The other types are usually below this elevation.

Lumbering and Other Industries

There are saw mills at Enderby, on the Shuswap river, and at points on Shuswap lake and along Eagle river. The mills at Enderby and at Shuswap lake get some of their supplies of logs outside the Railway Belt.

Small areas along Shuswap river and lake afford favourable conditions for agricultural pursuits. This is especially true around the towns of Enderby and Salmon Arm. The climatic conditions are favourable to fruit-growing, but mixed farming is likely to be more profitable. On most of the areas alienated for agricultural purposes, a limited amount of timber grazing is available. It is estimated that 277 square miles, or 11·5 per cent of the whole, comprises the area within which agricultural development will be carried on. Of this, 10 square miles carries statutory timber.

Railway Belt—Kamloops and Lytton Section

Position and Physical Features

This section lies almost entirely within the dry belt, and comprises the area drained by the Thompson river and by a portion of the Fraser river. The South Thompson river discharges Shuswap lake and joins the North Thompson at Kamloops. Below Kamloops it is known as the Thompson river. The latter follows a westerly course, to Ashcroft, where it takes an abrupt turn to the south, debouching into the Fraser river at Lytton. The principal tributaries of this river are the North Thompson and Bonaparte rivers, which enter it from the north, and Nicola and South Thompson rivers from the south. Only the lower reaches of the three first named lie within the Railway Belt. The section of the Fraser river that traverses the extreme western portion of the Railway Belt has a southerly trend. The valleys of all these rivers have a pronounced U-shaped form, and their bottoms are from a few hundred to 4,000 feet below the level of the uplands. The lowest altitude of the region is the Fraser river at Lytton, about 475 feet. The uplands have an altitude varying from 3,000 to 4,000 feet, with some areas reaching above 6,000.

At Kamloops (altitude 1,161 feet), the mean annual temperature is 47°, with a winter mean of 26°, and a summer mean of 67°. The highest recorded temperature is 102°, and the lowest −31°. Spence Bridge, at the mouth of the Nicola river (altitude 774 feet), has a mean annual temperature of 48°, with a winter mean of 25°, and a summer mean of 68°. The highest recorded temperature is 105°, and the lowest −29°. These two stations give a fair average of temperature conditions in the Thompson valley. At higher altitudes the climate is much cooler.

Kamloops has an annual precipitation of 11 inches, and Spence Bridge 9 inches. Edith lake, near Kamloops, altitude 2,000 feet, shows a one-year record of 16 inches, indicating, as would be expected, that the precipitation increases with altitude. Probably some portions of the uplands will show a precipitation that will approach 20 inches.

Forest Conditions

Seven per cent of this area is above the merchantable timber-line, most of it within the east slope of the Coast range. Of the 5,232 square miles below the merchantable timber-line, 858 square miles is incapable of bearing merchantable timber. This leaves 4,374 square miles that can be called timber-land.

CLASSIFICATION OF LANDS, WITH AMOUNT OF STANDING TIMBER, IN THE KAMLOOPS-LYTTON SECTION OF THE RAILWAY BELT

Classes of land	Area, sq. miles	Percentage of entire area	Saw-timber, M.b.f.
Above merchantable timber-line	415	7	....
Below merchantable timber-line—			
Area carrying 10,000 b.f. or more per acre	44	·7	352,000
Area carrying between 5,000 and 10,000 b.f. per acre	370	6·5	1,420,800
Area carrying between 1,000 and 5,000 b.f. per acre	650	11·6	1,248,000
Area carrying young growth	3,310	58·6	....
Area incapable of carrying timber	177	3·1	....
Area carrying grass or very open forest	681	12·5	....
Total	5,647	....	3,020,800

Merchantable Timber, by Species

The amount of merchantable timber, by species, in the Kamloops-Lytton section of the Railway Belt, is as follows: Douglas fir, 863,040 M.b.f.; balsam, 70,400 M.b.f.; spruce, 540,480 M.b.f.; yellow pine, 1,209,600 M.b.f.; lodgepole pine, 337, 280 M.b.f.; total, 3,020,800 M.b.f.

Douglas fir, yellow pine and Engelmann spruce are the permanent forest types. Due to fires, the temporary lodgepole pine type has replaced large areas that were formerly covered with permanent types.

Lumbering and Other Industries

Several small mills are situated along the main line of the Canadian Pacific railway in the South Thompson valley. The largest mills draw their logs from outside the Railway Belt, since most of the merchantable timber in this belt is commercially inaccessible at present.

Stock-raising is the principal industry. A very large portion of the area is suitable for grazing, while dry farming is successful on the upper bench-lands and lower portions of the uplands. Crops cannot be raised in the valleys without irrigation. Fruit, vegetables, and forage crops are the staple irrigation products. Mining at present is not important. It is estimated that 1,541 square miles, or 27·3 per cent of the whole, comprises the area within which agricultural pursuits, mostly stock-raising, will be carried on. Of this, 34 square miles bears statutory timber.

SOUTH CENTRAL REGION

'Big Bend' of Columbia River and Canoe River Drainage Basins

Position and Physical Features

This area lies between the axis of the Monashee mountains on the west and the summit of the Rocky mountains on the east, and extends from the northern boundary of the Railway Belt nearly to Yellowhead pass. It comprises an area drained by the portion of the Columbia lying to the north of the Railway Belt and by Canoe river. The eastern section of the Columbia river and also all but the headwaters of the Canoe are in the Rocky Mountain trench. The western section of the Columbia occupies the northern end of the Selkirk trench.

Canoe river rises in the south-eastern end of the Cariboo mountains and flows east to the Rocky Mountain trench, where it takes a south-easterly course, and joins the Columbia river at the apex of the 'Big Bend.'

The altitude of the bottoms of the main valleys lies between 1,650 and 2,300 feet, where the Selkirk trench and Rocky Mountain trench, respectively, cross the northern boundary of the Railway Belt.

The rugged portion of the Rocky mountains, that lies to the east of the Rocky Mountain trench, has an average altitude of about 8,000 feet, with several peaks that reach 11,000 feet.

At the southern end, between the Rocky Mountain and Selkirk trenches, are the Selkirk mountains, having an altitude of between 7,000 and 8,000 feet, with a number of peaks rising to 10,800 feet. The Monashee mountains, which flank this area on the west, have an average altitude of about 7,000 feet.

For the most part, the region is situated well within the wet belt. While there are no climatic data for the region, the character of the vegetation indicates that it has a precipitation varying from 25 to 50 inches, between one-third and one-half of which is snow. The average mean temperature varies from 38° to 42°, the highest being in the lower altitudes of the Columbia river, north of Revelstoke.

Forest Conditions

Sixty-three per cent of the area is above merchantable timber-line. Of the 1,749 square miles, or 37 per cent, below this line, some 134 square miles is considered incapable of bearing merchantable timber, leaving 1,615 square miles as the area of timber-land. Proportional to the area, this basin carries heavier stands of timber than any other in the interior. This is due, primarily, to the relatively small amount of damage caused by fires. This, however, is only relative, and serious damage has been caused by fires in portions of the Canoe drainage and of the lower section of the Columbia drainage which lies in the Rocky Mountain trench, where the climate is generally dry. In the upper Canoe, over considerable areas, the original growth has been replaced by lodgepole pine.

CLASSIFICATION OF LANDS, WITH AMOUNT OF STANDING TIMBER, IN THE 'BIG BEND' OF THE COLUMBIA AND THE CANOE RIVER DRAINAGE BASINS

Classes of land	Area, sq. miles	Percentage of entire area	Saw-timber, M.b.f.
Above merchantable timber-line	2,969	63	....
Below merchantable timber-line—			
Area carrying 10,000 b.f. or more per acre	304	6·5	3,891,200
Area carrying between 5,000 and 10,000 b.f. per acre	361	7·6	1,732,800
Area carrying between 1,000 and 5,000 b.f. per acre	321	6·8	642,000
Area carrying young growth	629	13·3	....
Area incapable of carrying timber	134	2·8	....
Total	4,718	....	6,266,000

Merchantable Timber by Species

The distribution of merchantable timber by species, in the 'Big Bend' of Columbia River and Canoe River drainage basins, is as follows : Douglas fir, 443,108 M.b.f.; red cedar, 3,048,320 M.b.f.; hemlock, 1,019,728 M.b.f.; balsam, 176,680 M.b.f.; spruce,

1,452,844 M.b.f.; white pine, 112, 480 M.b.f.; lodgepole pine, 12,840 M.b.f.; total, 6,266,000 M.b.f.

Cedar-hemlock and cedar-spruce are the most important forest types of the region. The former lies in the bottom of the valleys and on the lower benches of the rivers of the Selkirk trench. The latter occupies the higher benches and lower slopes of this region, and the bottoms and all the benches and lower slopes of the rest of the drainage basin. Between 4,000 and 6,000 feet altitude, the Engelmann spruce prevails. The subalpine type in this drainage basin is composed of balsam fir, Engelmann spruce, white-bark pine, lodgepole pine and mountain hemlock, in varying proportions.

Lumbering and Agriculture

Lumbering operations in this region have not been extensive, but have been confined mainly to the portion of the Selkirk trench lying immediately north of the Railway Belt.

The natural outlet for the heavy stands of timber in the valleys of these drainage basins is down the Columbia river, to Revelstoke, or to the head of Upper Arrow lake. A small amount of timber is tributary to the Canadian Northern railway, where it crosses the headwaters of Canoe river.

The agricultural areas consist of narrow strips of land, lying here and there along the main trenches, and on some of their tributaries. They are, for the most part, heavily timbered. The cost of clearing and the relative inaccessibility of the region are against its immediate agricultural development. A few adventurous pre-emptors have invaded the upper regions of Canoe river, but, up to the present time, little or nothing has been done in the way of agriculture. It is estimated that 144 square miles, or 3·1 per cent of the whole, comprises the area within which agricultural pursuits may be carried on. Of this, 92 square miles bears statutory timber. The mineral resources of the region are not at present being utilized.

Adams and Seymour Rivers Drainage Basin

Position and Physical Features

This drainage basin comprises a triangular area which lies on the west slope of the Monashee mountains just north of the Railway Belt. Its eastern border is the summit of the Monashee range and its western border lies well towards the western edge of these mountains. It is separated from the North Thompson river by a low, and, for the most part, timbered divide.

Adams river rises in the extreme northern portion of the region, follows a southerly and south-westerly course, and enters the north end of Adams lake (altitude 1,357 feet). Besides Adams river, the main tributary of the lake is Cayenne creek, which drains the medial region between Adams and Seymour rivers.

Seymour river occupies the south-eastern section of the region, and empties into the north end of Seymour arm, a branch of Shuswap lake (altitude, 1,137 feet).

The Monashee mountains, the axis of which forms the eastern boundary of the basin under discussion, rise to an altitude of between 7,000 and 8,000

feet. With the exception of small isolated areas, there are no other mountains within this region higher than 6,000 feet. The average elevation of the areas between the different drainage lines is about 5,000 feet.

While there are no meteorological stations lying within the area, indications are that the precipitation is between 30 and 40 inches. The average temperature for the valleys will probably be between 38° and 43°.

Forest Conditions

Eighteen per cent of the area is above the line of merchantable timber. Of the 1,422 square miles below this line, 112 square miles is considered incapable of bearing timber, leaving 1,310 square miles as the timbered area.

Fires have damaged large areas within the region, particularly along the lower half of Adams river. Fires have, in places, extended over the divides, but heavy stands of timber still remain along Cayenne creek, the upper reaches of Adams river, and nearly all of Seymour river. Where the fires have been severe, lodgepole pine forms a considerable part of the reproduction, but, for the most part, the original forest growth is gradually re-stocking the burned areas.

CLASSIFICATION OF LANDS, WITH AMOUNT OF STANDING TIMBER, IN THE ADAMS-SEYMOUR DRAINAGE BASIN

Classes of land	Area, sq. miles	Percentage of entire area	Saw-timber, M.b.f.
Above merchantable timber-line	306	18	....
Below merchantable timber-line—			
Area carrying 10,000 b.f. or more per acre	48	2·7	614,200
Area carrying between 5,000 and 10,000 b.f. per acre	293	17·0	1,465,000
Area carrying between 1,000 and 5,000 b.f. per acre	380	21·9	729,600
Area carrying young growth	589	34·0	....
Area incapable of carrying timber	112	6·4	....
Total	1,728	....	2,808,800

The amount of merchantable timber, by species, in the Adams-Seymour drainage basin is as follows: Douglas fir, 390,610 M.b.f.; red cedar, 1,100,440 M.b.f.; hemlock, 421,320 M.b.f.; balsam, 182,690 M.b.f.; spruce, 587,892 M.b.f.; white pine, 125,848 M.b.f.; total, 2,808,800 M.b.f.

Cedar-hemlock, cedar-spruce and Engelmann spruce are the forest types of the region. Engelmann spruce lies above the 4,000-feet contour, and the cedar types below this altitude.

Lumbering and Other Industries

Lumbering operations have been carried on around the head of Seymour river, and along Adams lake and river as far north as Harbour creek. The outlet of this timber is through Seymour arm and Adams lake, to shipping points on Shuswap lake and South Thompson river.

Favourable patches of agricultural land are found around the head of Seymour arm and along Adams river, but, as yet, the country is very sparsely settled. It is estimated that 38 square miles, or 2·2 per cent of the

whole, comprises the agricultural area, of which 5 square miles carries statutory timber.

North Thompson River Drainage Basin

Position and Physical Features

This basin comprises the area drained by the North Thompson and its principal branches, excepting a section of the North Thompson that traverses the Railway Belt, and an area drained by Mahood river (Bridge creek), a branch of the Clearwater river.

The North Thompson river rises in the south-eastern slopes of the Cariboo mountains, a short distance north of the headwaters of Quesnel lake, and follows a south-westerly course to its junction with the Albreda river; thence the course is south to near Wire Cache station, where it makes an abrupt turn to the west to its confluence with the Clearwater. From this point it takes a southerly course and joins the South Thompson river at Kamloops.

The Clearwater river rises in a series of lakes near the head of Quesnel lake, and flows south to its junction with the North Thompson.

Barriere river is the only other important tributary of the North Thompson. It falls in about midway between the mouth of the Clearwater and Kamloops.

All the valleys have the distinct U-shaped form. The upper portions of the North Thompson river and its tributary, the Albreda, are flanked on either side by high mountains, that reach an altitude of 7,000 to 8,000 feet. The lower course of the river flows through the eastern border of the Fraser plateau, whose uplands have an average altitude of between 4,000 and 5,000 feet. The bottom of the valley of the North Thompson varies in altitude from 1,185 feet, at the northern boundary of the Railway Belt, to 2,866 feet at the Albreda summit. The Clearwater river has an altitude of 1,336 feet at its mouth, and of about 4,000 feet in the lakes near its headwaters.

With the exception of the headwaters of the Barriere river, the southern half of the North Thompson river is in the dry belt, and the valley has a precipitation of between 15 and 20 inches, with perhaps a slight increase for the neighbouring high regions, especially on the east. The conditions are the same for the lower portions of the Clearwater river. The northern half of the North Thompson is, however, well within the wet belt, and has a precipitation of more than 30 inches. The mean annual temperature of the southern half of the basin is probably between 43° and 45°. The mean annual for the valleys of the northern half is probably between 38° and 40°.

Forest Conditions

Thirty-nine per cent of the area is above the line of merchantable timber. Of the 3,945 square miles, or 71 per cent of the area, below this line, 239 square miles cannot produce merchantable timber, leaving 3,706 square miles as the area capable of growing timber.

Damage by fire in this region has been great. In places where repeated fires have prevailed, the usual lodgepole pine invasion is occurring. For the most part, however, the damage to the region has not been so great as to destroy all reproduction, though over large districts the re-stocking of these barren areas is at present incomplete.

CLASSIFICATION OF LANDS, WITH AMOUNT OF STANDING TIMBER, IN THE NORTH THOMPSON RIVER DRAINAGE BASIN

Classes of land	Area, sq. miles	Percentage of entire area	Saw-timber, M.b.f.
Above merchantable timber-line	1,586	28·7	....
Below merchantable timber-line—			
Area carrying 10,000 b.f. or more per acre	174	3·2	1,670,400
Area carrying between 5,000 and 10,000 b.f. per acre	393	7·1	1,886,400
Area carrying between 1,000 and 5,000 b.f. per acre	510	9·2	979,200
Area carrying young growth	2,629	47·5	....
Area incapable of carrying timber	229	4·1	....
Area carrying grass or very open forest	10	·2	....
Total	5,531	....	4,536,000

Merchantable Timber, by Species

The distribution of merchantable timber, by species, in the North Thompson River drainage basin, is as follows: Douglas fir, 631,440 M.b.f.; red cedar, 1,137,456 M.b.f.; hemlock, 364,032 M.b.f.; balsam, 420,192 M.b.f.; spruce, 1,794,240 M.b.f.; white pine, 71,136 M.b.f.; yellow pine, 19,584 M.b.f.; lodgepole pine, 97,920 M.b.f.; total, 4,536,000 M.b.f.

A narrow strip of yellow pine is found along the North Thompson river near the Railway Belt. Douglas fir flanks the yellow pine on either side, extending to an altitude of about 4,000 feet as far north as the mouth of Mad river, and a short distance up the Clearwater river.

The cedar-spruce type occurs at lower altitudes at the headwaters of the Barriere river, also along the northern portions of the North Thompson and Clearwater valleys. Between the altitudes of 4,000 and 6,000 feet is the Engelmann spruce type. The subalpine type is above 6,000 feet altitude, and comprises Engelmann spruce, balsam fir, lodgepole pine and white-bark pine.

Lumbering Operations

Lumbering operations in this drainage basin have been confined, up to the present, mostly to the valleys of the North Thompson and Barriere rivers. The Canadian Northern railway has, however, rendered more accessible the heavy stands of timber in the northern section of the Thompson watershed. The heavy stands at the headwaters of the Clearwater can be driven down the Clearwater or carried across a short portage to Quesnel lake. The Clearwater is not considered a good driving stream, and the latter outlet will probably prove the more economical. From Quesnel lake the timber can be driven down the Quesnel river. If the Pacific Great Eastern railway, now under construction, is completed, it can be taken out by this line or by a branch to the foot of Quesnel lake.

Other Industries

The mineral resources of this region are not, at present, being developed commercially. Considerable areas of agricultural land lie along the southern section of the North Thompson, the Clearwater and the Barriere rivers. The northern section of the North Thompson watershed has narrow strips of agricultural land in places.

Agriculture is well developed along the lower North Thompson and Barriere rivers. It consists mostly of mixed farming. The adjacent timber lands afford fairly good grazing. Fruit can be raised at certain sites near the southern end, but, as a whole, the country is best adapted for stock raising. It is estimated that 262 square miles, or 4·7 per cent of the whole, comprises the area within which agricultural pursuits will be carried on. Of this, 4 square miles bears statutory timber.

Bonaparte and San Jose Rivers and Mahood River Drainage Basins

Position and Physical Features

These drainage basins comprise that portion of the Fraser plateau that lies between the Fraser river and the water-parting west of the lower North Thompson river. They extend from the northern boundary of the Railway Belt to the divide of the Quesnel River drainage.

With the exception of the northeastern third, the waters of this region reach the Fraser river. The northeastern third, comprising the drainage of Mahood river,* drains into the Clearwater, a branch of the North Thompson.

Bonaparte river drains the greater part of the southern portion of the region, and the San Jose river, the north-western portion. Between these two rivers, on the west, are a number of small streams, which drain directly into Fraser river.

This basin has an altitude of 675 feet, in its extreme southwestern corner, on the Fraser river, and 7,400 feet, in the Marble mountains, near the southwestern corner. The average altitude of the region is about 3,500 feet. One-sixth of the area lies below the 3,000-feet contour, one-half between 3,000 and 4,000 feet, and one-third above 4,000 feet.

The precipitation of this region varies, from 12 inches along the Fraser river, to about 20 inches at the higher altitudes. The lower altitudes along Fraser river have a mean annual temperature of about 45°, with a summer mean of 66°, and a winter mean of 24°. The mean annual temperature of Clinton (altitude 3,040 feet) is 40°, with a summer mean of 50° and a winter mean of 20°; the highest temperature recorded here is 96° and the lowest −51°. Most of the region of the plateau north of Clinton will probably have a mean annual temperature of between 35° and 40°, though no climatic data are available to show this.

Forest Conditions

Only two per cent of the area is above the line of merchantable timber. Of the 6,082 square miles below this line, 4,865 square miles is considered capable of growing merchantable timber. Large areas of this region have been badly burned. These areas are re-stocking, mostly with lodgepole pine. Some of the area classified as open land is capable of producing timber. It was reduced to this condition by repeated fires. Such areas contain good grazing, and will probably never be allowed to re-stock with forest growth.

* Mahood river was formerly known as Bridge creek.

CLASSIFICATION OF LANDS, WITH AMOUNT OF STANDING TIMBER, IN THE DRAINAGE BASINS OF BONAPARTE AND SAN JOSE RIVERS AND BRIDGE CREEK

Classes of land	Area, sq. miles	Percentage of entire area	Saw-timber, M.b.f.
Above merchantable timber-line	141	2·	....
Below merchantable timber-line—			
Area carrying 10,000 b.f. or more per acre	....	....	....
Area carrying between 5,000 and 10,000 b.f. per acre	106	1·8	508,800
Area carrying between 1,000 and 5,000 b.f. per acre	640	10·3	1,305,600
Area carrying young growth	4,119	66·2	....
Area incapable of carrying timber	334	5·4	....
Area carrying grass or very open forest	883	14·3	....
Total	6,223	....	1,814,400

Merchantable Timber by Species

The amount of merchantable timber by species, is as follows: Douglas fir, 1,026,720 M.b.f.; red cedar, 5,088 M.b.f.; balsam, 101,760 M.b.f.; spruce, 274,752 M.b.f.; yellow pine, 160,000 M.b.f.; lodgepole pine, 246,080 M.b.f.; total, 1,814,400 M.b.f.

The greater part of the area below 4,000 feet was formerly covered with the Douglas fir type of forest; this has been completely obliterated, over large areas, and replaced by stands of lodgepole pine. In the southern portion of the region, along the Bonaparte river and other small streams, there are small patches of the yellow pine type. These patches represent the northern extension of this type in British Columbia. Above 4,000 feet altitude, the spruce type prevails, where it has not been destroyed by fire and replaced by lodgepole pine. The small area above 6,000 feet altitude has the subalpine type, which here consists of alpine fir, Engelmann spruce and lodgepole pine.

Lumbering and Other Industries

Scattered throughout the district are small portable mills, which cut timber for local use only. Most of the district is too dry to carry heavy stands of timber. The patches of Douglas fir will average not over 3,000 or 4,000 feet per acre, while spruce will average about 6,000 feet per acre.

The region under consideration is primarily adapted to stock-raising. Besides the large areas of open lands, there is, in the aggregate, a considerable area of open glades in patches throughout the remaining forest, and these, with the small meadows around the numerous lakes, afford very good grazing.

Where irrigation is practicable, the small area on the benches of the Fraser river in the southwestern portion of the region is well adapted for fruit-growing. Other areas, favourably situated, have proven suitable for dry farming. It is estimated that 1,030 square miles, or 16·5 per cent of the whole, comprises the area within which agricultural pursuits, mostly stock raising, may be carried on. Of this, 883 square miles is too dry to carry merchantable timber.

Bridge and Chilcotin Rivers Drainage Basins

Position and Physical Features

This region comprises that section of the Fraser River watershed drained principally by Chilcotin and Bridge rivers. It extends from Fraser river, on the east, to the summit of the

Coast mountains, on the west. It includes, also, the headwaters of the Homathko river, which rises in the Fraser plateau, and breaks through the Coast mountains, finding its outlet in the Pacific ocean. Bridge river lies in the extreme southern portion of the region, and drains a high un-named spur of the Coast mountains. The headwaters of the Chilcotin consist of several lakes that lie near the eastern base of the Coast mountains. The main river has a general southerly and south-westerly course and debouches into the Fraser river. Besides these principal streams, there are a number of smaller ones.

The altitudes of the region vary from 675 feet, the lowest level of Fraser river, to the high levels of the Coast mountains. Peaks in these mountains rise to a height of over 9,600 feet. The altitude of the plateau, which comprises the largest part of the area, is from 3,000 to 3,500 feet. The valley of the Fraser river is U-shaped in form, flanked on either side by well-defined benches. It is from 2,000 to 2,500 feet below the level of the uplands. The valley of the Chilcotin is similar to that of the Fraser, except that towards its headwaters the bottom of the valley is much higher. Chilko lake, the headwaters of the Chilko branch of the Chilcotin, has an altitude of 3,860 feet, and lies well within the Coast mountains. Tatla lake, the headwaters of the Chilanko branch of the Chilcotin, has an altitude of 2,980 feet. Tatlayako lake, near the headwaters of Homathko river, has an elevation of 2,723 feet.

The region lies within the dry belt, and hence the precipitation is usually low. The region of lowest altitudes along the Fraser river is arid and covered with sagebrush. Its annual precipitation is probably less than 10 inches, though a five-year average for Lillooet (altitude 840 feet) shows a precipitation of 15 inches. Big Creek (altitude 3,100 feet) has an annual precipitation of 12 inches, about one-third of which is in the form of snow. A one-year record for a station in the Bridge River valley (altitude 1,800 feet) is 16 inches. Lillooet has a mean annual temperature of 45°, with a winter mean of 24° and a summer mean of 66°. Chilcotin (Big Creek), on the other hand, has a mean annual temperature of 37°, with a winter mean of 17°, and a summer mean of 57°. The highest recorded temperature for this station is 102° and the lowest −50°.

Forest Conditions

Twenty-nine per cent of the area is above the merchantable timber-line. Of the 9,279 square miles, or 71 per cent, below this line, 1,335 square miles cannot carry timber of merchantable value. This leaves a total of 7,944 square miles for timber-land. The 907 square miles of open or semi-open lands are, for the most part, too dry for growing timber. Repeated fires have, no doubt, been responsible for reducing a part of this area to its present condition. Fires have burned over nearly the entire area, most of which is now reproducing with lodgepole pine.

Merchantable Timber, by Species

The amount of merchantable timber, by species, in the drainage basins of Chilcotin and Bridge rivers, is as follows: Douglas fir, 947,200 M.b.f.; balsam, 119,296 M.b.f.; spruce, 330,650 M.b.f.; white pine 3,891 M.b.f.; yellow pine, 287,232 M.b.f.; lodgepole pine, 503,091 M.b.f.; total, 2,191,360 M.b.f.

CLASSIFICATION OF LANDS, WITH AMOUNT OF STANDING TIMBER, IN THE DRAINAGE BASINS OF BRIDGE AND CHILCOTIN RIVERS

Classes of land	Area, sq. miles	Percentage of entire area	Saw-timber, M.b.f.
Above merchantable timber-line	3,708	219	....
Below merchantable timber-line—			
Area carrying 10,000 b.f. or more per acre	....	....	....
Area carrying between 5,000 and 10,000 b.f. per acre	38	·3	194,560
Area carrying between 1,000 and 5,000 b.f. per acre	1,040	7·9	1,996,800
Area carrying young growth	6,866	52·7	....
Area incapable of carrying timber	428	3·2	....
Area carrying grass or very open forest	907	6·9	....
Total	12,987	....	2,191,360

For a short distance along Fraser river, and in patches along Bridge river, the yellow pine type is found. Over most of the area, the Douglas fir type comprised the original forest, but, as a result of fires, it has been replaced to a large extent by the temporary lodgepole pine type. Above 3,500 feet altitude the Engelmann spruce type is found.

The few small mills found in the region cut lumber for local use only. Cattle raising is the principal industry. The open lands afford winter grazing when the snow is not deep. Open glades occur at many points in the vast area of the timber-covered portion, and these increase the grazing possibilities of the region to a material extent. Some alpine grazing lands occur in the high mountains, but, as a rule, these areas are little utilized. Natural meadows supply hay for winter feed, but forage is raised also on irrigated lands along or near the Fraser river. When irrigated, the lands at low altitudes in the extreme southeastern portion of the region are capable of growing fruit.

It is estimated that 941 square miles, or 7·2 per cent of the whole, comprises the area within which agricultural pursuits can be carried on. Of this, 907 square miles contains little or no forest growth.

Nechako and Blackwater Rivers Drainage Basins

Position and Physical Features

This large region, comprising 22,529 square miles, includes the portion of the Fraser plateau drained by the Nechako river (except the Stewart River branch), the Blackwater river, and the upper portions of the Dean, Bellakula and Klinaklini rivers. It extends from the Fraser river on the east to the axis of the Coast mountains on the west. The three last named rivers break through the Coast mountains and fall into the Pacific ocean.

The altitude of the uplands of the plateau is between 3,000 and 4,000 feet, gradually rising westward into the high, rugged Coast mountains. Scattered throughout the plateau are isolated peaks and mountain ranges, which vary in altitude from 5,000 to 7,000 feet. The valleys of the plateau lie from a few feet to 1,000 feet below the uplands. A prominent feature of the region is the large number of lakes, which have a total area of 894 square miles. The largest of these are the Eutsuk (altitude 2,810 feet), Ootsa (2,700 feet), François

(2,375 feet), and Fraser lake (2,192 feet). Quesnel (altitude 2,250 feet), situated on the Fraser river, at the eastern border, has a mean annual temperature of 40°, with a winter mean of 20°, and a summer mean of 60°. This station probably represents the mildest temperature conditions of the region, except, perhaps, some portion of the Dean River valley, where temperature conditions may be modified by the warmer currents of air coming from the coast.

Quesnel has an annual precipitation of 14 inches, about one-third of which is in the form of snow. The average for the plateau is probably between 14 and 20 inches, though the eastern foothills of the Coast mountains may perhaps show a precipitation of from 25 to 30 inches.

Forest Conditions

There are considerable areas covered with grass, especially along the Blackwater river, but their situation is not accurately defined. The table indicates that 8 per cent of the area is above the merchantable timber-line. Perhaps no region in the southern half of British Columbia has been so badly burned as this, yet a very large percentage of it has a forest cover of some kind. The areas of grass have probably been brought to their present condition by fires.

CLASSIFICATION OF LANDS, WITH AMOUNT OF STANDING TIMBER, IN THE NECHAKO-BLACKWATER DRAINAGE BASINS

Classes of land	Area, sq. miles	Percentage of entire area	Saw-timber, M.b.f.
Above merchantable timber-line	1,725	8	....
Below merchantable timber-line—			
Area carrying 10,000 b.f. or more per acre	....	....	....
Area carrying between 5,000 and 10,000 b.f. per acre	141	·6	676,800
Area carrying between 1,000 and 5,000 b.f. per acre	2,970	13·1	3,801,600
Area carrying young growth	15,779	69·9	....
Area incapable of carrying timber	1,914	8·4	....
Total	22,529	....	4,478,400

Distribution of Merchantable Timber

The merchantable timber, by species, in the Nechako and Blackwater drainage basins is as follows : Douglas fir, 617,040 M.b.f.; hemlock, 67,680 M.b.f.; balsam, 481,680 M.b.f.; spruce, 2,707,920 M.b.f.; lodgepole pine, 604,080 M.b.f.; total, 4,478,400 M.b.f.

The principal forest types of the region are the Engelmann spruce-alpine fir type and the lodgepole pine type. Toward the western and north-western portions, on warmer sites, there are areas that contain the Douglas fir type, and there are indications that it formerly covered larger areas in this part of the region. Toward the foothills of the Coast mountains there are small areas covered with the hemlock-Engelmann spruce type.

Lumbering and Other Industries

There are a few small mills on the Fraser river and along the line of the Grand Trunk Pacific, but logging operations have practically ceased since the construction of this railway. The timber of this region is not likely to be marketed for a long time. Except for small areas, it is mostly immature.

Large areas around the lakes and along the main Nechako and its branches and on portions of the Blackwater, have been surveyed and mostly alienated for agricultural purposes. The region, as a whole, is best suited for dairy-farming and stock-raising. Forage and root crops, hardy vegetables and grains can be grown, but summer frosts are likely to prevent cereals from ripening. There are considerable areas of more or less timbered land, which can be used for grazing purposes.

It is estimated that 2,420 square miles, or 10·1 per cent of the whole, comprises the area within which agricultural pursuits can be carried on.

Quesnel River Section of Fraser River Drainage Basin

Position and Physical Features

This section of the Fraser drainage basin lies between the 52nd and 53rd parallels of latitude, and east of the Fraser river. Its eastern boundary is the divide between the headwaters of the Quesnel and Clearwater rivers. Quesnel lake is the most important geographical feature in the Quesnel drainage. Its headwaters are not far distant from Hobson lake of the Clearwater drainage. The general trend of Quesnel lake is east and west ; its outlet, Quesnel river, has a general north-east course and debouches into Fraser river at Quesnel town.

About two-thirds of the drainage lies along the south-western slopes of the Cariboo mountains, the remaining third being within the Fraser plateau. The Cariboo mountains here have an altitude of 7,000 to 8,000 feet. From this, the altitude of the region becomes lower, through the foothills of the Cariboo mountains, to the Fraser plateau, where the average elevation is 3,000 feet. The descent from this plateau to the Fraser river is abrupt. The latter lies in a U-shaped valley, the bottom of which averages about 1,500 feet altitude.

The average precipitation of the Fraser valley itself is 15 inches, about one-third of which is in the form of snow. There is a gradual increase in the precipitation from the river to the foothills of the Cariboo mountains, where it averages about 20 inches. In the valleys of the foothills, and along the south-western slopes of the Cariboo mountains, the precipitation will average from 20 to 40 inches, three-sevenths of which is in the form of snow.

The annual mean temperature of this portion of the Fraser valley is 40°, with a winter mean of 20° and a summer mean of 60°. The highest temperature recorded is 100° and the lowest −50°. At the higher altitudes, the mean annual temperature is probably 35° for the valleys, and below this for the mountains.

Forest Conditions

Eighteen per cent of this drainage basin is above the merchantable timber-line. With the exception of 433 square miles, all the area below this line is considered capable of bearing timber.

Merchantable Timber

The amount of merchantable timber, by species, in the Quesnel River drainage basin is as follows : Douglas fir, 286,800 M.b.f.; red cedar, 1,720,800 M.b.f.; hemlock, 573,600 M.b.f.; balsam,

860,400 M.b.f.; spruce, 2,179,680 M.b.f.; lodgepole pine, 114,720 M.b.f.; total, 5,736,000 M.b.f.

CLASSIFICATION OF LANDS, WITH AMOUNT OF MERCHANTABLE TIMBER, IN THE QUESNEL DRAINAGE BASIN

Classes of land	Area, sq. miles	Percentage of entire area	Saw-timber, M.b.f.
Above merchantable timber-line	1,099	18·2	....
Below merchantable timber-line—			
Area carrying 10,000 b.f. or more per acre	55	1·0	528,000
Area carrying between 5,000 and 10,000 b.f. per acre	729	12·2	3,499,200
Area carrying between 1,000 and 5,000 b.f. per acre	890	14·9	1,708,800
Area carrying young growth	2,769	46·4	....
Area incapable of carrying timber	385	6·5	....
Area carrying grass or very open forest	48	·8	....
Total	5,975	....	5,736,000

The forest types of the region are the Engelmann spruce-alpine fir, the cedar-hemlock, the cedar-spruce, the Douglas fir, and the temporary lodgepole pine. The Engelmann spruce-alpine fir type occurs above the 4,000-feet contour. The Douglas fir type is confined to the drier portions of the basin, and the cedar types to the moister regions, below 4,000 feet. The lodgepole pine type is confined to the drier portions of the region that have been badly burned. The subalpine type occurs usually above the 5,500-feet contour, and consists of Engelmann spruce, alpine fir and lodgepole pine, with some white-bark pine.

Industrial Activities

With the exception of a few small mills situated near the settlements, no lumbering operations have been carried on in this region. The natural outlet for the comparatively heavy stands of timber around Quesnel lake and its tributaries is down the Quesnel river to Quesnel town, on the line of the projected Pacific Great Eastern railway. A more practicable outlet for this timber could be secured through the construction of a branch line from this railway to Quesnel lake.

Placer gold mining has long been carried on in the valley of the main Quesnel river and its tributary, the Horsefly.

The portions of the drainage basin that are suitable for agriculture are situated along the Fraser river and the small streams in the southwestern portion of the basin. Stock-raising is the principal industry, with forage crops as the principal agricultural product. Favourable sections can, however, be utilized for dry farming. It is estimated that 286 square miles comprises the area within which agricultural pursuits will be carried on.

Willow and Bowron Rivers Drainage Basins

Position and Physical Features

This region comprises that portion of the Fraser drainage that lies between the north end of the Cariboo mountains on the east, and, on the west, a low range of wooded mountains, which parallel the Fraser river from near the city of Prince George to the town of

Quesnel. The area lies mainly in the northern foothills of the Cariboo mountains, but the northern portion of it can be considered as a part of the Fraser plateau.

Both the Bowron (Bear) and Willow rivers rise in the water-parting that separates them from the drainage of Quesnel river and Cottonwood creek. They have a general northerly course. The Bowron river empties into the Fraser, near the mouth of McGregor river. Willow river joins the Fraser, 25 miles above Prince George. Small portions of the foothills of the Cariboo mountains reach an altitude of over 5,000 feet. The valleys of the two rivers vary in altitude from 2,000 to 4,000 feet. That portion of the Fraser plateau which lies within these basins has an average elevation of from 2,000 to 2,500 feet.

The only meteorological station within the basins is Barkerville (altitude 4,180 feet), which lies in a mountainous valley near the headwaters of Willow river. Its mean annual temperature is 35°, with a winter mean of 19° and a summer mean of 53°. The highest recorded temperature is 93°, and the lowest −46°. The precipitation at this station is 36 inches. Barkerville represents probably the lowest temperature and the highest moisture conditions for the valleys of this region. The precipitation for the drier northern portion of the region is probably about 20 inches, and the mean annual temperature is near 38°.

Forest Conditions

Eleven per cent of the area is above the line of merchantable timber, here estimated to be at the 5,000-feet contour line. The region shows evidence of having been burned over about 100 years ago. This old burn, however, has reforested itself, with the exception of the northern and southern parts, which have again been burned more recently. This new forest is now nearly mature, and covers more than one-half of the area of the two basins in question.

CLASSIFICATION OF LANDS, WITH AMOUNT OF STANDING TIMBER, IN THE WILLOW-BOWRON DRAINAGE BASINS

Classes of land	Area, sq. miles	Percentage of entire area	Saw-timber, M.b.f.
Above merchantable timber-line	354	11	....
Below merchantable timber-line—			
Area carrying 10,000 b.f. or more per acre	31	1·1	297,600
Area carrying between 5,000 and 10,000 b.f. per acre	1,399	44·5	6,715,200
Area carrying between 1,000 and 5,000 b.f. per acre	390	12·4	748,800
Area carrying young growth	859	27·3	....
Area incapable of carrying timber	116	3·7	....
Total	3,149	....	7,761,600

Merchantable Timber by Species

The amount of merchantable timber, by species, in the Willow-Bowron drainage basins is as follows: Douglas fir, 350,640 M.b.f.; hemlock, 70,128 M.b.f.; balsam, 813,600 M.b.f.; spruce, 5,049,792 M.b.f.; lodgepole pine, 1,477,440 M.b.f.; total, 7,761,600 M.b.f.

The Engelmann spruce-alpine fir type covers nearly the entire region below the 4,000-feet contour line. There is evidence that a larger amount of Douglas fir was formerly intermixed with this species. Areas of the temporary lodgepole pine type are to be found where severe burns have occurred. Small patches of spruce-hemlock type exist in the vicinity of Purden lake, near the Bowron river.

Lumbering Operations

The Grand Trunk Pacific railway crosses the northern end of this region, from the mouth of the Bowron to the mouth of Willow river. At the mouth of Willow river, a large mill is logging the timber that lies immediately adjacent, while a small mill operates at Giscome station, near Eaglet lake. Logging operations have, so far, not been extensive.

Most of the timber lies along the upper half of the two rivers that drain this region. At present, this timber is not considered easily accessible, because portions of these rivers offer difficulties in driving. Since the bulk of the timber is not yet mature, the natural obstacles in the way of easily lumbering it are not detrimental at the present time.

Gold mining has long been the principal industry of the region around the town of Barkerville. The land suitable for agriculture lies near the Grand Trunk Pacific Ry. A few settlers have taken up pre-emptions along this railway, but thus far, only a very small area has been actually cultivated. The climate permits raising hardy vegetables and grains, as well as root and forage crops. The region is perhaps best suited for dairy farming.

It is estimated that 248 square miles, or 7·9 per cent of the whole, comprises the area within which agricultural pursuits can be carried on. Of this, 57 square miles carries statutory timber.

Upper Fraser River Drainage Basin

Position and Physical Features

This region comprises the area drained by the upper Fraser river and its main branch, the McGregor river, known also as the North fork.

The Fraser river rises in the Rocky mountains, near Yellowhead pass and flows in a generally westerly direction to Tête Jaune, where it enters the Rocky Mountain trench. From this point, it has a northwest trend to its confluence with the McGregor. This section of the Fraser lies within a broad U-shaped trench, flanked, for the greater part, on both sides by high mountains that reach an altitude of 8,000 feet or more. The bottom of this valley, at its junction with McGregor river, has an altitude of 2,000 feet ; the summit of Yellowhead pass is 3,722 feet above sea level.

The Rocky mountains, which flank the river on the northeast, are drained by a number of streams, the most important being the Torpy (Clearwater), Morkill and Holmes. The Cariboo mountains flank the river on the southwest. The northeast slopes of these mountains are drained by a number of small tributaries of the upper Fraser ; of these, the most important are the Raush, Dore and Goat rivers.

McGregor river rises in the watershed range of the Rocky mountains, at about lat. 54°, long. 120°. It has a general westerly course, and, after receiving a number of branches, mostly from the north, debouches into the Fraser at the western limit of the region. A portion of the lower McGregor valley and the valley of Bad river probably constitute part of the Rocky Mountain trench.

Tête Jaune (altitude 2,402 feet), situated in the driest portion of the region, has a one-year precipitation record of about 16 inches. Judging from the character of the vegetation, the annual precipitation in the western part of the upper Fraser valley must be about 30 inches, or perhaps more.

Forest Conditions

Fifty-seven per cent of the drainage basin of the upper Fraser lies above merchantable timber-line. Below this line, 160 square miles is considered incapable of bearing forest growth, leaving 3,082 square miles of timber-land.

The eastern section of the part of the basin drained by the upper Fraser has been badly burned, and is mostly replaced by lodgepole pine growth. Otherwise, the region is heavily forested.

CLASSIFICATION OF LANDS, WITH AMOUNT OF STANDING TIMBER, IN THE UPPER FRASER RIVER DRAINAGE BASIN

Classes of land	Area, sq. miles	Percentage of entire area	Saw-timber, M.b.f.
Above merchantable timber-line	4,349	57	....
Below merchantable timber-line—			
Area carrying 10,000 b.f. or more per acre	378	5·0	3,628,800
Area carrying between 5,000 and 10,000 b.f. per acre	1,247	16·5	5,985,600
Area carrying between 1,000 and 5,000 b.f. per acre	420	5·6	806,400
Area carrying young growth	1,037	13·8	....
Area incapable of carrying timber	160	2·1	....
Total	7,591	....	10,420,800

Merchantable Timber, by Species

The amount of merchantable timber, by species, in the Upper Fraser River drainage basin is as follows : Douglas fir, 847,632 M.b.f.; red cedar, 3,109,200 M.b.f.; hemlock, 371,856 M.b.f.; balsam, 1,050,144 M.b.f.; spruce, 4,718,496 M.b.f.; lodgepole pine, 323,472 M.b.f.; total, 10,420,800 M.b.f.

Cedar-spruce and Engelmann spruce-alpine fir are the principal forest types of the region. The former occupies the bench lands on either side of the Fraser, in the moister portions of the basin. The mountain slopes, the entire valley of McGregor river, and the greater portion of the tributary valleys from an elevation of 3,000 feet to 4,500 feet, carry the Engelmann spruce-alpine fir type. Patches of Douglas fir type occupy specially warm sites in the eastern section of the basin.

Lumbering Operations

Lumbering operations have not been extensive in the past. The completion of the Grand Trunk Pacific railway through the entire valley of the main Fraser has, however, rendered

easily accessible a large amount of virgin timber. The region thus offers facilities for cheap logging, and it should soon become a very important logging centre. The amount of lumber likely to be cut here will depend for the most part upon the demand from the farming regions of northern Alberta.

A strip of land from two to three miles wide has been surveyed for agricultural purposes, along the portion of the valley which lies in the Rocky Mountain trench. Some of this land is covered with heavy timber, and very little of it has yet been brought under cultivation. Because of the rather severe climatic conditions, the region seems to be best adapted to dairy farming. Root and forage crops and hardy grains and vegetables can be grown.

It is estimated that 509 square miles, or 6·7 per cent of the whole, comprises the agricultural area. Of this, 370 square miles is, at present, covered with statutory timber.

NORTH CENTRAL REGION

Parsnip River Drainage Basin

Position and Physical Features

This region includes the area drained by Parsnip river, with the exception of its main tributary, Nation river. This basin lies north of the Upper Fraser drainage basin and southwest of the axis of the Rocky mountains. Parsnip river rises in the Rockies and flows southwesterly to the Rocky Mountain trench. Thence, it flows northwest in this trench, to its confluence with the Finlay, to form Peace river.

The section of the Rocky mountains drained by Parsnip river is much lower than that portion of the mountains to the southeast. The highest known peak in the Parsnip drainage has an altitude of 7,689 feet. Low, timbered passes connect the west and east slopes. Of these, the lowest is Pine pass (altitude 2,850 feet). The water-parting in the Rocky Mountain trench, between Bad river and the Parsnip basin, is 2,300 feet above sea level. The average elevation of the plateau that forms the western portion of this drainage basin is about 3,000 feet.

While there are no meteorological stations within the region, accounts of explorers indicate that the upper reaches of Parsnip river have a precipitation of well over 30 inches. In the lower portion of the river and on the adjacent plateau the precipitation is, in some localities, probably as low as 15 inches.

Forest Conditions

Twenty-three per cent of the area lies above the line of merchantable timber. Of the 3,451 square miles, or 77 per cent, below this line, all but 169 square miles is timber-land.

The greater portion of the burned area lies in the Fraser plateau portion of the drainage basin.

Species of Merchantable Timber

The amount of merchantable timber, by species, in the Parsnip River drainage basin, is as follows : Douglas fir, 36,912 M.b.f.; balsam, 1,476,500 M.b.f.; spruce, 5,536,875 M.b.f. ; lodgepole pine, 332,213 M.b.f.; total, 7,382,500 M.b.f.

CLASSIFICATION OF LANDS, WITH AMOUNT OF STANDING TIMBER, IN THE PARSNIP RIVER DRAINAGE BASIN

Classes of land	Area, sq. miles	Percentage of entire area	Saw-timber, M.b.f.
Above merchantable timber-line	1,041	23	....
Below merchantable timber-line—			
Area carrying 10,000 b.f. or more per acre	21	·5	201,600
Area carrying between 5,000 and 10,000 b.f. per acre	1,001	22·3	5,804,800
Area carrying between 1,000 and 5,000 b.f. per acre	695	15·5	1,376,100
Area carrying young growth	1,565	34·9	....
Area incapable of carrying timber	169	3·8	....
Totals	4,492	....	7,382,500

Except where it has been replaced by the temporary lodgepole pine type, the principal forest type of the region is the Engelmann spruce-alpine fir type. The small amount of Douglas fir of the region is found on specially warm sites, mixed with the spruces, or carrying small areas in nearly pure stands.

No logging operations have yet been carried on in this region. Should the projected railway from Prince George to the Alberta prairies, by way of Pine pass, be built, the timber of this basin will find a ready outlet.

At present, little or no land is cultivated in the region, though there are a few settlers in the valley of the lower Parsnip. It is estimated that 175 square miles, or 3·9 per cent of the whole, comprises the area within which agricultural pursuits can be carried on. Of this, 32 square miles is covered with statutory timber.

Stuart, Salmon and Nation Rivers Drainage Basins

Position and Physical Features

The drainage basins of the Stuart and Salmon rivers lie in the extreme northern portion of the Fraser plateau. Under the name of the Driftwood river, Stuart river rises in about lat. 56°, long. 127°, and flows southeastward to Tacla lake. Stuart river discharges Tacla lake and flows in a southeasterly direction through Trembleur and Stuart lakes to its confluence with the Nechako river, about 50 miles above the city of Prince George. Comparatively low, wooded water-partings separate it from the Babine drainage on the west, and from the Nation and Salmon drainage on the east.

The Nation River basin lies in the northeastern portion of the region. The river rises a short distance from Tacla lake. It has a general easterly course, and the upper half of the river broadens out into what are known as the Nation lakes. The Nation river falls into the Parsnip, about 35 miles above its confluence with the Finlay.

Salmon river occupies the southeastern section of this region. It rises in about lat. 55°, long. 124°, has a general southeasterly course, and debouches into the Fraser river a short distance above Prince George.

The general altitude of this region is about 3,000 feet, though there are a number of peaks and low mountain ridges that vary in altitude from 5,000 feet to more than 6,000 feet.

A distinguishing characteristic of this region is the large number of lakes, varying in altitude from 2,200 to 2,400 feet. These lakes aggregate some 632 square miles in area.

Climatic data at Fort St. James, which lies at the lower end of Stuart lake and has an altitude of 2,280 feet, show an annual mean temperature of 33°, with a winter mean of 12°, and a summer mean of 53°. The highest recorded temperature is 97°, and the lowest is −55°. The annual mean precipitation is 15 inches, about one-third of which is in the form of snow. These climatic data probably represent an average for the valleys of the entire region, but, doubtless, the uplands have a slightly greater precipitation and a lower temperature.

In contrast with the southern portion of the Fraser plateau, this region, together with the Nechako-Blackwater basin to the south of it, is, in spite of its comparatively low precipitation, capable of producing merchantable forest growth throughout the greater part of its area, up to an altitude of 5,000 feet. This is due to a better conservation of soil moisture, resulting from lower temperature conditions.

Forest Conditions

Only six per cent of the area is above the line of merchantable timber. Of the 10,116 square miles below this line, 1,652 square miles is incapable of carrying merchantable timber. The area has been badly burned. Where fires have been severe, it is re-stocking mostly with lodgepole pine, though, on patches where the soil is deep, poplar is the first invading species.

CLASSIFICATION OF LANDS, WITH AMOUNT OF STANDING TIMBER, IN THE STUART, NATION AND SALMON RIVERS DRAINAGE BASINS

Classes of land	Area, sq. miles	Percentage of entire area	Saw-timber, M.b.f.
Above merchantable timber-line	645	6	....
Below merchantable timber-line—			
Area carrying 10,000 b.f. or more per acre	122	1·1	1,161,200
Area carrying between 5,000 and 10,000 b.f. per acre	692	6·4	3,321,600
Area carrying between 1,000 and 5,000 b.f. per acre	1,290	12·0	2,476,800
Area carrying young growth	6,360	59·1	....
Area incapable of carrying timber	1,652	15·4	....
Total	10,761	....	6,959,600

Merchantable Timber, by Species

The amount of merchantable timber, by species, in the Stuart-Nation-Salmon River drainage basins is as follows : Douglas fir, 804,360 M.b.f.; balsam, 695,960 M.b.f.; spruce, 4,697,540 M.b.f.; lodgepole pine, 761,740 M.b.f.; total, 6,959,600 M.b.f.

The Engelmann spruce-alpine fir type is the principal forest type. In the southern portion of the Stuart and Salmon basins, this type contains, at the lower altitudes, a mixture of Douglas fir, which, apparently, was more abundant in the original forest than at present. On special sites, there are small areas covered with stands of pure or nearly pure forests of this species. Over large areas, lodgepole pine has entirely replaced the original forest.

Lumbering and Agriculture

Practically none of the timber has been utilized commercially. There are no saw-mills, and, until the more accessible timber of the province is utilized, the timber resources of this region will probably not be in demand for general use. With adequate protection from fire, the large area of young growth will, in time, reach maturity, when, perhaps, better transportation facilities will render accessible the very large amount of timber the region will then contain. This area should accordingly be regarded as a reservoir to supply the demands of a distant future.

A considerable area of land has been classified by the provincial authorities as suitable for agriculture, but the area is unutilized, save for a few patches here and there. Root crops, hardy grains and vegetables and forage crops can be grown, though summer frosts are not infrequent. Dairy-farming is likely to prove the chief agricultural industry.

It is estimated that 1,022 square miles, or 9·5 per cent of the whole, comprises the area within which agriculture will be carried on. Of this, 63 square miles is now covered with statutory timber.

Upper Skeena River Drainage Basin

Position and Physical Features

This region comprises a very large area and is drained by that portion of the Skeena river east of the axis of the Coast mountains. It lies mostly in the physiographic unit that has been called the Skeena system, but a portion of it is in the northwestern part of the Fraser plateau and some on the east slope of the Coast mountains. The main Skeena river rises in a pass that connects it with the headwaters of the Stikine river, in about lat. 57° 15′, long. 128° 30′. From this point it has a southeasterly course, to its junction with the Sustut river. It then follows a westerly course, thence south, and makes an abrupt turn to the east to its confluence with the Babine. From this point it has a southerly course, to the town of Hazelton, at the junction of the Skeena and Bulkley rivers. From Hazelton it follows a general southwesterly course, emptying into the Pacific ocean a short distance south of Prince Rupert.

The principal tributaries of the Skeena are the Sustut, Babine, Kispiox, Bulkley, Kitwanga, Kitsumgallum and Zymoetz rivers.

The Sustut river rises in the western slopes of the Omineca range and flows southwesterly to the Skeena. The Babine river rises opposite Fraser lake and flows into Babine lake, nearly 100 miles long. From the lake it flows northwesterly to the Skeena. The Kispiox is a comparatively short stream, that joins the Skeena a short distance above Hazelton. Bulkley river rises near the headwaters of the Endako river, a tributary of the Nechako. It has a general northwest course, and receives two main branches from the southwest, the Telkwa and the Morice. The Zymoetz river rises near the head of the Morice, flows in a general northwesterly direction and enters the Skeena near the town of Terrace. The Kitsumgallum heads opposite a branch of the Nass and flows south in the Kitimat trench to its confluence with the Skeena.

The Skeena system consists of a series of plateaus, broken by a number of mountain ranges. Of these, the Babine range, which lies between the Bulkley and Babine rivers, is the most important. These mountains reach a height of over 7,000 feet, and are divided into two parts by the Suskwa river, a tributary of the Bulkley. Lying to the southwest of the Bulkley river are a number of high ranges of mountains, known as the Rocher Déboulé, the Hudson Bay and the Telkwa mountains. Portions of these ranges reach an altitude of over 9,000 feet.

The Kitwanga river rises opposite the headwaters of Cranberry river, a tributary of the Nass. It flows south, entering the Skeena at the town of Kitwanga. It is separated from the Kispiox river by a range of mountains that has an altitude of over 5,000 feet. West of this river, and penetrated by the Skeena and Zymoetz rivers, are the east slopes of the Coast mountains. All these rivers have usually the well-defined U-shaped valleys throughout their length.

The lowest altitude of the upper Skeena basin is 190 feet, at the mouth of the Zymoetz river. At Hazelton, at the mouth of the Bulkley, the altitude is about 725 feet, while at the headwaters of the Bulkley, it is 2,363 feet. Babine lake has an altitude of 2,222 feet. The headwaters of the main Skeena have an elevation of about 4,000 feet. The portion of the Skeena above its junction with the Babine is bordered on the west by a comparatively low divide that separates it from the upper reaches of Nass river.

The climate of the western portion of the upper Skeena drainage basin is more or less influenced by its proximity to the coast. The eastern portion, however, has a climate that is more nearly characteristic of the interior region still further to the east. No data are available as to conditions of temperature. A number of stations have a one-year record for precipitation. Thus, at New Hazelton (altitude 1,030 feet) situated behind the Rocher Déboulé mountains, the precipitation is 19 inches ; McClure lake (altitude about 2,000 feet) has a precipitation of 24 inches, about one-fifth of which is snow. At the Fifth cabin (altitude about 3,000 feet), on the Yukon telegraph line, situated in a pass between the Skeena and Nass basins, the precipitation for eleven months of one year was 34 inches, about two-fifths of which was snow. The town of Terrace, lying just below the mouth of Zymoetz river, has a precipitation of about 39 inches.

These figures show that the precipitation throughout the basin is extremely variable. In general, the region west of the Babine mountains has a precipitation of between 20 and 40 inches, while the Skeena valley, from the mouth of the Kitwanga to the mouth of the Zymoetz, probably has from 30 to 40 inches.

This section of the drainage basin contains an extension of the hemlock-Sitka spruce coast type of forest. In the remainder of the basin, west of the Babine range, Sitka spruce is replaced by Engelmann spruce. Hemlock is mixed with this on special sites, usually at altitudes above 2,000 feet. Cedar occurs on the upper benches of the Skeena. up to 40 miles north of Hazelton,

and also on similar sites a short distance up the Bulkley and its tributary, the Suskwa. On the other hand, the headwaters of the Babine and Bulkley contain neither hemlock nor cedar, the Engelmann spruce-alpine fir and lodgepole pine types being the principal ones in this portion of the drainage area.

Forest Conditions

Forty-three per cent of the area is above the line of merchantable timber. Of the 9,494 square miles below this line, some 950 square miles is incapable of carrying merchantable timber; this leaves 8,544 square miles as timber-land. While much of this land has been badly burned, a large proportion of it still carries timber, though the amount has been considerably reduced by fire.

CLASSIFICATION OF LANDS, WITH AMOUNT OF STANDING TIMBER, IN THE UPPER SKEENA RIVER DRAINAGE BASIN

Classes of land	Area, sq. miles	Percentage of entire area	Saw-timber, M.b.f.
Above merchantable timber-line	7,206	43	....
Below merchantable timber-line—			
Area carrying 10,000 b.f. or more per acre	136	·8	1,305,600
Area carrying between 5,000 and 10,000 b.f. per acre	877	5·3	4,207,600
Area carrying between 1,000 and 5,000 b.f. per acre	2,410	14·4	4,627,000
Area carrying young growth	5,121	30·8	....
Area incapable of carrying timber	950	5·7	....
Total	16,700	....	10,140,400

Merchantable Timber, by Species

The amount of merchantable timber, by species, in the Upper Skeena River drainage basin is as follows: Red cedar, 336,412 M.b.f.; hemlock, 783,224 M.b.f.; balsam, 1,584,116 M.b.f.; spruce, 6,590,580 M.b.f.; lodgepole pine, 744,664 M.b.f.; cottonwood, 101,404 M.b.f.; total, 10,140,400 M.b.f.

The Engelmann spruce-alpine fir, the Sitka spruce-hemlock, the cedar-hemlock, and the Engelmann spruce-hemlock types are the principal forest types of this drainage basin. Lodgepole pine and poplar occur in some places on badly burned lands, and are usually well mixed with spruce reproduction. Along the flood plains of the Skeena river there is usually a well-marked zone of cottonwood.

Lumbering and Agriculture

There are a few small saw-mills along the line of the Grand Trunk Pacific railway, which traverses this region, but lumber is being sawn only for local use. Most of the timber is not readily accessible, and it is likely to be a long time before it is utilized for other than local needs.

At present, the medial portion of the Bulkley valley is the most active agricultural district in the central portion of British Columbia. Stock-raising is the principal industry. Open patches of the forested areas afford fairly good grazing. Hardy grains, forage crops, root crops and vegetables are the principal agricultural products raised. The Kispiox valley and small areas in the Skeena valley below the Kispiox have agricultural prospects. A portion of the area around Babine lake is said to have good agricultural land ; here, dairy

farming probably offers the best prospects of success. It is estimated that 608 square miles, or 3·6 per cent of the whole, comprises the area within which agricultural pursuits can be carried on. Of this, 56 square miles is at present covered with merchantable timber.

Mineral resources abound in the region, and some of the mines are operating on a commercial basis. Coal measures have been discovered at the heads of the Telkwa, Skeena, Nass and Stikine rivers, but commercial development will not be practicable until better transportation facilities become available.

Upper Nass River Drainage Basin

Position and Physical Features

This region comprises the area drained by that portion of Nass river that lies east of the axis of the Coast mountains. The Nass river rises in about lat. 56° 50′, long. 130°, opposite the headwaters of the Iskut river, and empties into Observatory inlet, in lat. 55°, long. 130°. Important tributaries of Nass river are Cranberry river and the North fork. As stated above, Cranberry river rises opposite the headwaters of the Kitwanga river. The valleys of the Cranberry and Kitwanga rivers are what has been described as a 'through valley,' connecting the Nass and Skeena drainages. The medial section of the Nass valley is said to be about 40 miles wide, before it rises abruptly into the area of higher elevation on either side. This portion of the valley has an altitude which varies from the level of the Nass to 3,000 feet, at the foot of the higher land on either side.

The Coast mountains, that flank the region on the west, are high and rugged, and have a considerable portion of their area covered with glaciers and perpetual snow.

At Ninth cabin, on the Yukon telegraph line, situated near the headwaters of the North fork, an eleven-months record shows a precipitation of 23 inches. From the accounts of explorers, the lower Nass valley has a comparatively heavy precipitation, probably about 40 inches. Toward the headwaters of the river, this gradually diminishes to, probably, 25 inches ; the presence of hemlock throughout the valley also indicates this precipitation. The temperature of the basin is influenced by its proximity to the coast, which is a comparatively mild climate for its latitude.

Forest Conditions

Fifty-one per cent of the area is above the line of merchantable timber, which here occurs at about the 4,000-feet contour. Of the 3,764 square miles, or 49 per cent of the area, below this line, all but 174 square miles is considered capable of producing timber. Only a comparatively small proportion of the area has been damaged by fire ; such areas are re-stocking fairly satisfactorily, with lodgepole pine, poplar, spruce, hemlock and balsam, and are rapidly recovering their former forested condition.

Species of Merchantable Timber

In the Upper Nass drainage basin, the amount of merchantable timber by species is : Red cedar, 990,880 M.b.f.; hemlock, 3,269,904 M.b.f.; balsam, 3,368,992 M.b.f.; spruce, 2,279,024 M.b.f.; total, 9,908,800 M.b.f.

CLASSIFICATION OF LANDS, WITH AMOUNT OF STANDING TIMBER, IN THE UPPER NASS DRAINAGE BASIN

Classes of land	Area, sq. miles	Percentage of entire area	Saw-timber, M.b.f.
Above merchantable timber-line	3,850	51	....
Below merchantable timber-line—			
Area carrying 10,000 b.f. or more per acre	17	0·2	163,200
Area carrying between 5,000 and 10,000 b.f. per acre	1,428	18·6	6,846,400
Area carrying between 1,000 and 5,000 b.f. per acre	1,510	19·7	2,899,200
Area carrying young growth	635	8·3	....
Area incapable of carrying timber	174	2·2	....
Total	7,614	....	9,908,800

On the lower Nass, as far as the mouth of Cranberry river, the principal type is the hemlock-Sitka spruce. Above Cranberry, it is replaced by the hemlock-Engelmann spruce type. Small patches of the cedar-hemlock type occur in the lower Nass valley, and the upper headwaters contain the spruce type, with a heavy mixture of balsam.

No lumbering activities have occurred in this region. The natural outlet for the timber, however, would be by driving down the Nass river, for milling at some point on the coast. The timber is not likely to be utilized for a long time, except for possible local needs.

Mining has not passed much beyond the prospecting stage ; some development work has been done, but no minerals are mined on a commercial basis. Besides other minerals, coal occurs at the headwaters of the Nass, Stikine, and Skeena rivers.

Agriculturally, the conditions seem best adapted for dairy farming. Root crops, hardy grains and forage crops would presumably constitute the principal agricultural products. Grazing is available in the more or less open areas of forest. Few settlers have established themselves, and the number is not likely to be greatly increased until the country is opened up by railway transportation.

It is estimated that 124 square miles, or 1·1 per cent of the whole, represents the area within which agricultural pursuits can be carried on. Of this, 73 square miles is covered with statutory timber.

Finlay River Drainage Basin

Position and Physical Features

The portion of the Rocky Mountain trench occupied by the Finlay river and its tributary, Fox river, constitutes the axis of this basin. Finlay river rises in lat. 57°, long. 127° 30′, near the southern end of the axis of the Cassiar mountains. Fox river rises in Sifton pass, in lat. 58°, and flows south-southeast to its junction with the Finlay. The altitude of the bottom of the Rocky Mountain trench increases from about 2,000 feet, where the Finlay and Parsnip rivers unite to form Peace river, to about 3,500 feet, at Sifton pass.

The axis of the Rocky mountains forms the eastern boundary of the Finlay drainage basin ; the western boundary is formed by the axis of the Omineca range and the southern end of the Cassiar mountains.

The rivers that drain the western slope of the Rocky mountains are mostly short; some of them, however, that assume a direction parallel to the axis of the range are considerably longer. The general altitude of the Rockies in this basin is about 6,000 to 7,000 feet, with individual peaks of over 8,000 feet.

The Omineca range is a general term applied to the mass of irregular short ranges separated from each other by the western tributaries of Finlay river. These mountains have an altitude of 6,000 to 7,000 feet, with some peaks of about 9,000 feet. Small glaciers are present at some places. The valleys between the ranges are U-shaped in cross-section. The principal western tributaries of the Finlay are the Ingenika, Omineca and Manson rivers.

There are no meteorological stations within this region, but indications are that for most of the region the precipitation is well below 20 inches, and that the mean annual temperature is about 33° for the southern portion of the Rocky Mountain trench. For the northern portion of the trench, and for the higher elevations, the temperature is probably lower. On especially warm days in the summer, a temperature of 90° or higher is said to be reached.

Forest Conditions

Sixty-seven per cent of the area is above merchantable timber-line, which occurs at about the 4,000-feet contour. Of the 6,290 square miles below this line, 651 square miles is incapable of bearing timber, leaving 5,639 square miles as the wooded area. Of this 4,201 square miles is more or less covered with young forest growth. The region has been badly damaged by fire, and large areas are re-stocking with lodgepole pine, or with this species in mixture with spruce.

CLASSIFICATION OF LANDS, WITH AMOUNT OF STANDING TIMBER, IN THE FINLAY RIVER DRAINAGE BASIN

Classes of land	Area, sq. miles	Percentage of entire area	Saw-timber, M.b.f.
Above merchantable timber-line	12,571	67	....
Below merchantable timber-line—			
Area carrying 10,000 b.f. or more per acre	....	....	....
Area carrying between 5,000 and 10,000 b.f. per acre	263	1·3	1,262,400
Area carrying between 1,000 and 5,000 b.f. per acre	1,175	6·2	2,256,000
Area carrying young growth	4,201	22·2	....
Area incapable of carrying timber	651	3·3	....
Total	18,861	....	3,518,400

Distribution of Merchantable Timber

The amount of merchantable timber, by species, in the Finlay River drainage basin is: Balsam, 70,368 M.b.f.; spruce, 2,638,800 M.b.f.; lodgepole pine, 809,232 M.b.f.; total, 3,518,400 M.b.f.

Engelmann spruce-alpine fir and lodgepole pine types are the principal forest types of the region. The latter has replaced the former over large areas. The sub-alpine type consists, for the most part, of balsam, with some spruce and lodgepole pine.

Placer mining on a small scale is being carried on in the region. In connection with placer mining, two mills are found in the region, one on the Omineca,

the other on Manson river, but they have not been in operation for a number of years. From a commercial viewpoint, the timber is inaccessible at the present time.

Considerable areas of land along the lower part of the Finlay have good soil, and could be utilized for the raising of hardy agricultural products, principally forage crops and vegetables. Some alpine grazing is available, principally in the neighbouring Omineca range, but there is little grass in the valley.

It is estimated that 356 square miles comprises the area within which agricultural pursuits can possibly be carried on. Of this, 39 square miles contains statutory timber.

REGION EAST OF ROCKY MOUNTAINS

South Pine River Drainage Basin

Position and Physical Features

This region comprises all of British Columbia south of the Peace river and east of the axis of the Rocky mountains, with the exception of the Peace River block. The region is drained, for the most part, by the South Pine river, which rises in the axis of the Rocky mountains and flows in a general northeasterly direction. The extreme southern portion of the region, however, is drained by the headwaters of the Wapiti branch of Smoky river, this, in turn, being a tributary of Peace river. Except in the extreme southern portion of the region, the altitude of the Rocky mountains in this basin is comparatively low. At the extreme south, however, one peak has an altitude of 10,000 feet. The east slope of the Rocky mountains grades off imperceptibly into the region of the Great plains, which comprise an area, triangular in shape, immediately south of the southern boundary of the Peace River Block. The uplands of these plains have an altitude of from 2,000 to 3,000 feet; the valleys are from a few feet to several hundred feet below these elevations.

Practically no climatic data are available for this region. Reference is, however, made to the discussion under the description of the Peace River Block. (See page 307.)

Forest Conditions

Twenty-three per cent of the area lies above the merchantable timber line, which here occurs at about the 4,500-feet contour. Of the 6,700 square miles below this line, 1,171 square miles has been so badly burned that it cannot be reforested, except at great expense. Of this area, 278 square miles is now clothed with grass or very open forest. This lies mainly along the southern boundary of the Peace River Block, and is probably an extension of what is known as the Pouce Coupé prairie. The main bodies of merchantable timber within the region lie in the valleys of the eastern slopes of the mountains.

The amount of merchantable timber, by species, in the South Pine River drainage basin is: Balsam, 331,260 M.b.f.; spruce, 4,637,640 M.b.f.; lodgepole pine, 1,656,300 M.b.f.; total, 6,625,200 M.b.f.

CLASSIFICATION OF LANDS, WITH AMOUNT OF STANDING TIMBER, IN THE SOUTH PINE RIVER DRAINAGE BASIN

Classes of land	Area, sq. miles	Percentage of entire area	Saw-timber, M.b.f.
Above merchantable timber-line	2,061	23	....
Below merchantable timber-line—			
Area carrying between 5,000 and 10,000 b.f. per acre	943	11·0	4,526,400
Area carrying between 1,000 and 5,000 b.f. per acre	1,090	12·6	2,098,800
Area carrying young growth	3,496	40·0	....
Area incapable of carrying timber	893	10·2	....
Area carrying grass or very open forest	278	3·2	....
Total	8,761	....	6,625,200

Engelmann spruce-alpine fir is the principal forest type of the region. Over large areas, due to fires, this has been replaced by the lodgepole pine type. White spruce is present in the region, though it is not known to what extent this species is represented in the spruce stand. It is estimated that 220 square miles comprises the area within which agricultural pursuits may possibly be carried on.

For a discussion of lumbering and other industries of the region, see description of the Peace River Block following.

Peace River Block

Position and Physical Features

This block includes a strip approximately 74 miles wide from north to south and traversed by the Peace river. It extends from long. 122° to the boundary between British Columbia and Alberta. It comprises about 3,500,000 acres, is under the control of the Dominion Government, and, hence, is considered apart from the regions north and south of it. This block, and the portions of the general region to the north and south of it, are, from the standpoint of commercial possibilities, considered a part of what is generally known as the Peace River district, which lies entirely within the physiographic unit known as the Great plains.

This portion of the Great plains has an average altitude of from 2,000 to 3,000 feet, while the valleys of the rivers are from a few feet to 600 or 800 feet below this level. Peace river traverses the block from west to east and cuts it into two nearly equal portions. The main tributaries from the north are North Pine and Halfway rivers, and those from the south are the Moberly, South Pine and Kiskatinaw (Cutbank) rivers. All these rivers have their headwaters beyond the limits of the block.

No meteorological data are available that will justify a definite statement of the conditions of precipitation and temperature of the block. The mean summer temperature at Dunvegan, Alta., on Peace river, some distance east of the block, is stated to be 58°, while Fort St. James, on Stuart lake, west of the Rocky mountains, has a mean summer temperature of 53°. The figure for the Peace River Block is probably slightly lower than that for Dunvegan. Summer frosts are likely, especially in late August. The mean winter temperature is much lower, however, in the Peace River Block than at

Fort St. James, judging from a comparison of the data for this latter station with Dunvegan. Thus, while Fort St. James has a mean winter temperature of 12°, Dunvegan has a winter mean of 1°.

The moisture seems to be sufficient for tree growth, for evidently the region was formerly covered with an unbroken forest. The prairie condition which prevails over a portion of the area is believed to be due to the destruction of the former forest by repeated fires, rather than to the lack of sufficient precipitation. Judging from comparison with other regions, where the vegetation is similar, this region probably has an average annual precipitation of about 15 inches. It is reported that, during the winter, there is from 14 to 20 inches of snow.

Forest Conditions

None of the area of the block lies above merchantable timber-line. Thirty per cent is treeless, about one-half, or 900 square miles, being fire-made 'prairie.' Fires have done severe damage to the forest. On 380 square miles the forests have been so badly burned that there is no reproduction on the land. The balance is re-stocking, mostly with lodgepole pine and poplar; the latter forms groves on the richer soils.

The figures of the following table are adapted from a reconnaissance report made by J. A. Doucet, of the Dominion Forestry Branch. Some slight changes have been made in these figures to make the discussion conform to that of the other drainage basins.

CLASSIFICATION OF LANDS, WITH AMOUNT OF STANDING TIMBER, IN THE PEACE RIVER BLOCK

Classes of land	Area, sq. miles	Percentage of entire area	Saw-timber, M.b.f.
Below merchantable timber-line—			
Area carrying 10,000 b.f. or more per acre	259	4·7	1,921,000
Area carrying between 5,000 and 10,000 b.f. per acre	410	7·5	1,762,000
Area carrying between 1,000 and 5,000 b.f. per acre	473	8·6	862,000
Area carrying young growth	2,637	48·1	....
Area incapable of carrying timber	808	14·7	....
Area carrying grass or very open forest	900	16·4	....
Total	5,487	....	4,545,000

The amount of merchantable timber in the Peace River Block includes 3,269,000 M.b.f. of spruce and 1,276,000 M.b.f. of lodgepole pine, making a total of 4,545,000 M.b.f.

In addition to the spruce and pine there is estimated to be 415,000 M.b.f. of poplar (90 per cent aspen), 15,000 M.b.f. of tamarack and 7,000 M.b.f. of birch which might be sawn. It is doubtful if even a small percentage of this will ever be used as lumber. Including all the small timber in the young and old forests, Mr. Doucet estimates that there is, in addition to the above, 11,000,000 cords of wood, chiefly poplar and lodgepole pine.

Three principal forest types are distinguished, namely, spruce (probably mostly white spruce), lodgepole pine and poplar. The two latter are temporary

types and are due to fires. The lodgepole pine type occupies the poorer soils, while the poplar type represents the first stage of recovery on the better soils. Both of these types may or may not be mixed with spruce. The swampy areas carry tamarack and black spruce.

So far as known no saw-mills are at present in operation within the block or in the adjoining basins, to the north and south of it.

The fact that pre-emptors are rapidly settling the region is fairly good proof of its possibilities as a farming district. Hardy varieties of wheat and other cereals are said to do well. The region has been much advertised as regards its agricultural possibilities. Probably it will ultimately become a mixed farming country, with stock raising as the chief industry, the poorer soils, whether open or covered with timber, furnishing spring, summer and fall grazing. It is estimated by Mr. Doucet that 1,817 square miles comprises the area within which agricultural pursuits can be carried on.

Drainage Basins of the North Pine and Halfway Rivers

Position and Physical Features

With the exception of that portion lying in the Peace River Block, these drainage basins comprise all the area north of Peace river and east of the axis of the Rocky mountains, to the divide that separates the Peace River drainage from the Fort Nelson River drainage. Its eastern boundary is the dividing line between Alberta and British Columbia, and its western boundary is the axis of the Rocky mountains. It comprises a portion of the east slope of the Rocky mountains and of the Great plains.

North Pine river has a general southeasterly to southerly course, crosses the northern boundary of the Peace River Block, and empties into the Peace. Halfway river rises near the axis of the Rocky mountains, in Laurier pass. It has a general southeasterly direction, crossing into the Peace River Block before it joins the Peace. The Rocky mountains within this region are comparatively low and grade imperceptibly into the Great Plains region. The divide between the North Pine and Fort Nelson rivers averages about 3,500 feet in altitude. From this divide the region slopes toward the south, to an altitude of 2,000 or 2,500 feet at the northern boundary of the Peace River Block. (For a description of the climatic conditions see page 307.)

Forest Conditions

Very little is known about the forest conditions of this region. The following indicates the situation, according to the best information available.

Thirty-two per cent of the area is above merchantable timber-line. Of the 4,129 square miles below, there are known to be 28 square miles of merchantable timber, mostly along North Pine river. Probably, other such areas exist, but specific information is not available. Of the remaining land below merchantable timber-line, it is estimated that 2,274 square miles is re-stocking. Some of this, perhaps, has merchantable timber. The remaining 1,827 square miles includes badly burned areas not re-stocking, 'fire-made' prairies, swamps,

and other areas that cannot be made to grow merchantable timber without great expense.

The amount of timber is estimated to be 134,400,000 board feet, and consists of spruce (probably white spruce). The burned areas are re-stocking with lodgepole pine and poplar, or with these species mixed with spruce. Tamarack and black spruce are found in the swamps. The area which may be of use for agriculture is roughly estimated at 600 square miles. (For lumbering operations and other industries see page 309.)

CLASSIFICATION OF LANDS, WITH AMOUNT OF STANDING TIMBER, IN THE NORTH PINE RIVER AND HALFWAY RIVER DRAINAGE BASINS *

Classes of land	Area, sq. miles	Percentage of entire area	Saw-timber, M.b.f.
Above merchantable timber-line	1,961	32	....
Below merchantable timber-line—			
Area carrying between 5,000 and 10,000 b.f. per acre	28	0·6	134,400
Area carrying between 1,000 and 5,000 b.f. per acre †	....	....	....
Area carrying young growth	2,274	37·4	....
Area incapable of carrying timber ‡	1,827	30	....
Total	6,090	....	134,400

Fort Nelson Section of the Liard Drainage

Position and Physical Features

This vast area, nearly 39,000 square miles, comprises that portion of the province which lies east of the axis of the Rockies and north of the divide which separates it from the Peace River drainage. Approximately, it stretches from lat. 57° to lat. 60°, and from long. 120° to long. 126°. It is largely drained by Fort Nelson river, a branch of the Liard, which rises near the headwaters of the North Pine, a tributary of Peace river. Fort Nelson river has a tortuous northerly course, joining the Liard in about lat. 59° 30′. It receives important branches from the east and west, the latter draining the east slopes of the Rocky mountains.

The headwaters of Hay river drain a small portion of the region between lats. 58° and 59°, near the Alberta and British Columbia boundary. This river flows in an easterly and northeasterly direction, to Great Slave lake.

There is a short stretch of the Liard river in the northeastern portion of the basin. The Liard crosses the northern boundary of British Columbia from Yukon territory, makes an abrupt turn to the east, and, in about lat. 59° 30′, breaks entirely through the Rocky Mountain system. It traverses the Rockies at an altitude of approximately 1,500 feet, the lowest pass in the Rocky mountains. At its confluence with Fort Nelson river, a short distance east of the mountains, it turns to the Northeast and recrosses the northern boundary of the province into the Northwest Territories, before emptying into the Mackenzie river.

* Information concerning the forest conditions of these basins is incomplete; the figures in this table are only a rough estimate.

† Information incomplete.

‡ Includes a rough estimate of an unknown area of prairie or very open forest growth.

The east slopes of the Rocky mountains comprise the western portion of the region. For the most part, these mountains are unexplored. They probably have a general elevation of between 6,000 and 7,000 feet, with some peaks of over 8,000 feet. A considerable portion of the area is covered with glaciers and perpetual snow. Where the Liard river breaks through, the mountains are comparatively low, and are drained by a number of its tributaries.

The northwest extension of the Great plains comprises the region east of the foothills of the Rockies. The Plains consist here of a plateau, whose uplands have an average altitude varying between 2,500 and 3,000 feet at the south, and between 1,600 and 1,800 feet at the north. The valleys lie from a few feet to about 400 feet below the level of the plateau.

The table which follows contains a rough estimate of the areas of lands by classes and of the amount of timber. In the absence of sufficient data, no figures are given for the stand type carrying timber below 5 M.b.f. Probably large areas of this class exist. If so, they are included in the area shown for young forest growth.

Seventy-three per cent of the area lies below merchantable timber-line. Of this, 19,696 square miles is a rough estimate of the area that cannot be made to carry timber without great expense. Possibly under intensive management, a large part of it could be reforested.

CLASSIFICATION OF LANDS, WITH AMOUNT OF STANDING TIMBER, IN THE FORT NELSON SECTION OF THE LIARD DRAINAGE BASIN *

Classes of land	Area, sq. miles	Percentage of entire area	Saw-timber, M.b.f.
Above merchantable timber-line	10,634	27	....
Below merchantable timber-line—			
Area carrying 10,000 b.f. or more per acre	....	....	....
Area carrying between 5,000 and 10,000 b.f. per acre	158	0·5	778,400
Area carrying between 1,000 and 5,000 b.f. per acre†	....	....	....
Area carrying young growth	8,441	21·8	....
Area incapable of carrying timber ‡	19,696	50·7	....
Area carrying grass or very open forest †	....	....	....
Total	38,938	....	778,400

Description of Timber Resources

The amount of merchantable timber by species in the Fort Nelson section of Liard River drainage basin is as follows: Spruce, 700,560 M.b.f.; cottonwood, 77,840 M.b.f.; total, 778,400 M.b.f.

The region has been very badly burned. Near the foothills of the Rocky mountains, and on the drier parts of the plateau, there are said to be large areas that formerly carried forests, but are now reduced to the grass stage by repeated fires. Large areas on the uplands of the plains are occupied by

* The information concerning this drainage basin is incomplete, and the figures are only a rough estimate.
† Information incomplete.
‡ Includes a very large area of muskeg and some grass land.

swamps or muskeg. These, where too wet for tree growth, are covered with swamp grass, but, in their drier portions, they carry scrub tamarack and black spruce. To be conservative, these areas, together with other classes of terrain that will not bear merchantable forest growth, are estimated to cover about two-thirds of the area below merchantable timber-line.

The principal forest types of the region are the spruce-alpine fir and the lodgepole pine types. The latter occupies the poorer soils that have been burned over, and is more or less mixed with spruce. The swampy areas contain the non-commercial tamarack-black spruce type. The areas of virgin spruce lie along the principal streams.

This region offers more promise for agricultural development than does the adjoining portion of northern British Columbia which lies west of the Rockies. Wheat ripens at Fort Liard, which lies across the northern boundary of British Columbia, but is near the region under discussion. The large areas of grazing lands could be extended by further burning, should such action be considered advisable. It is altogether likely that, until transportation facilities are available and the larger and better areas to the south and east are settled, this region will not be very largely utilized for agriculture. If it should so develop, the available timber is adequate for local use.

NORTHERN REGION

Drainage Basin of the Dease and Kachika Branches of the Liard

Position and Physical Features

This drainage region lies in the central portion of the extreme northern section of British Columbia. There are within it portions of four physiographic units. These are the Yukon plateau, the Cassiar mountains, the Rocky Mountain trench and the Rocky mountains. The eastern boundary of the region is the axis of the Rocky mountains. These mountains are here comparatively low, and toward the north, where the Liard river traverses them, they break down.

The Kachika river, in at least the upper portion of its course, occupies the Rocky Mountain trench. The trench is narrow at its southern limits, but toward the north it broadens out and consists of a comparatively wide area that contains low hills, none of which rise above the merchantable timber-line. The Kachika river rises in the Sifton pass, at an altitude of about 3,500 feet, and flows north-northwest to its junction with the Liard river, where its altitude is about 1,600 or 1,700 feet. It receives from the west one important branch, the Turnagain river, which rises at the axis of the Cassiar mountains, just across the divide from the heads of tributaries of the upper Skeena river. The Turnagain has a general northerly course, entering Kachika river about 20 miles above the confluence of the Kachika and Liard.

The Cassiar mountains include an indefinite mass of ranges that extend from about lat. 57° to Dease river. In the southern portion of these mountains some peaks attain an altitude of about 8,000 feet or more, and a considerable part of these ranges is covered with glaciers and perpetual snow.

Toward the Dease river they decrease in altitude. Dease river rises in Dease lake (altitude 2,660 feet), in lat. 58° 40′, long. 130°. 05′. It has a general northeasterly course to its confluence with the Upper Liard, to form the Liard river. It thus drains the western slopes of the Cassiar mountains, besides a portion of their northern extension. Lying to the east of the Cassiar mountains is a small portion of the Yukon plateau, which will be described in another connection.

Very little is known about this region, except that the forest growth has been badly burned and, in places, has been completely destroyed. From the meagre information available, the following attempt has been made at a land classification of the region, with especial reference to its capacity to produce timber. No data are available for an estimate of the area or amount of standing merchantable timber.

CLASSIFICATION OF LANDS, WITH AMOUNT OF STANDING TIMBER, IN THE DEASE-KACHIKA DRAINAGE BASINS *

Classes of land	Area, sq. miles	Percentage of entire area
Above merchantable timber-line	12,158	68
Below merchantable timber-line—		
Area carrying young growth	4,340	24
Area incapable of carrying timber	1,446	8
Total	17,944	..

Approximately 68 per cent of the area is above the line of merchantable timber. Of the 5,786 square miles, or 32 per cent of the area, below this line, 4,340 square miles is restocking with some kind of timber growth. It is probable that a considerable portion of this land might be placed in the stand type of at least 1 M. to 5 M. board feet per acre. A small area around Dease lake is said to have such a stand, or, at least, timber of sufficient size to meet the local demands for mining timbers.

Of the remaining 1,446 square miles, a large part is said to be 'fire-made' prairie, and might be utilized for grazing purposes. Some of the land of this class is too wet for merchantable timber growth.

The types of forest within this area are the lodgepole pine and the white spruce-alpine fir types. The swamp-lands carry the tamarack-black spruce type, but, because of the scrubby character of the trees, this type cannot be considered merchantable.

Placer gold mining and fur-trading are the principal industries of the region. The placer gold fields of Dease lake have long been yielding small quantities of gold.

The region is accessible only with great difficulty and is entered usually by boat from Wrangell, Alaska, up the Stikine river to Telegraph Creek, thence by trail to Dease lake, and thence by boat or canoe down the Dease and Liard rivers to the various Hudson's Bay Co. posts.

* Very rough estimate.

Stikine and Unuk River Drainage Basins

Position and Physical Features

The drainage basins of these two rivers comprise the area that is situated between the axis of the Coast mountains on the west and the axis of the Cassiar mountains on the east. This region lies, for the most part, between the 57th and 58th parallels of latitude, though a tongue of it extends as far north as the 59th parallel, and there is another section which extends to the southeast, well below the 56th parallel.

Parts of three physiographic units comprise the basin ; these units are the Coast mountains, the Cassiar mountains, and a broad plateau lying between these ranges. As the axis of the Coast mountains forms the boundary between British Columbia and Alaska, only the eastern slopes are within the province. These mountains are, for the most part, high and rugged, with a large proportion of their area covered with glaciers and perpetual snow. Like the Skeena and Nass rivers to the south, the Stikine breaks through the Coast mountains, and the bottom of its valley is very near sea level where it crosses the boundary. The Coast mountains grade off imperceptibly into the plateau which comprises the area between their base and the northwestern base of the Cassiar mountains. The uplands of this plateau have a general altitude of between 3,000 and 4,000 feet, and the valleys are from a few feet to 2,000 feet below the general level of the plateau. The Cassiar mountains have a general altitude of 6,000 to 7,000 feet, with some peaks of over 8,000 feet. Portions of the latter are covered with glaciers and perpetual snow.

Stikine river rises in the western slopes of the Cassiar mountains, at the extreme southeastern portion of the region, in lat. 57°, long. 128° 30′, not far from the headwaters of the Skeena and Nass rivers. From this point it follows a general northerly direction to near lat. 58°; thence it turns west, maintaining this westerly course to near the town of Telegraph Creek, lat. 57° 55′, long. 131° 10′. From Telegraph Creek it flows southwest to the eastern base of the Coast range, whence it maintains a nearly southerly course to the British Columbia-Alaska boundary. From this point it turns abruptly to the west, entering tide-water near Wrangell, Alaska.

Throughout its course it receives a number of tributaries, the most important of which is the Iskut river. The latter rises in some lakes near lat. 57° 30′, not far from a tributary of the Stikine river ; it follows a general southerly course to lat. 57°, thence westerly, joining the Stikine near the Alaska boundary. The Klappan river rises a short distance from the source of the Stikine ; it has a northwesterly course, entering the Stikine from the south. The other tributaries of the Stikine are the Second South fork from the south, and the East Fork, Pitman, Tuya and Tanzilla, from the north. Tanzilla river rises a short distance north of the mouth of Klappan river, flows north to near the head of Dease lake, then makes an abrupt turn to the southwest, joining the Stikine a few miles above Telegraph Creek. Tuya river rises in a lake in about lat. 59°, flows south and joins the Stikine a short distance below the mouth of the Tanzilla.

The altitude of the bottom of the valley of the Stikine river varies, from about 4,000 feet at its source, to tide-water at its mouth. At Telegraph Creek it is about 540 feet. For most of its course it has a rather wide U-shaped form in cross section. For a considerable distance above Telegraph Creek, it flows through the Grand cañon, a deep gorge in the basaltic rocks of the region.

Unuk river drains a small section of this region, lying on the west slopes of the Coast range, between lat. 56° and 57°. A low pass connects it with branches of the Iskut and Nass rivers, respectively. The Unuk flows south-east, crosses the Alaska boundary at an elevation of 250 feet, and eventually reaches tide-water at the head of Unuk inlet. A short distance from the boundary, the river passes through a cañon, above which the valley broadens out, and, with its branches, has a considerable area that carries a comparatively heavy stand of timber.

There are no climatic records for any portion of the Stikine and Unuk basins. The valleys of the Unuk and of the portions of the Stikine and the Iskut that traverse the Coast mountains, are influenced, to some extent, by the moist, comparatively mild, climate of the adjoining Alaska coast ; their climate is, however, more severe so far as temperate conditions are concerned. Ascending the Stikine river, the precipitation decreases and the temperature changes. For example, the climate at Telegraph Creek, altitude 540 feet, is very dry. The summers are exceedingly hot, with a maximum temperature of more than 90° in the shade ; on the other hand, the winters are severely cold. From the accounts of explorers, the western slopes of the Cassiar mountains have a heavier precipitation than the Yukon plateau lying to the west of them. The precipitation in the valleys of these slopes is probably well over 20 inches.

CLASSIFICATION OF LANDS, WITH AMOUNT OF STANDING TIMBER, IN THE STIKINE-UNUK DRAINAGE BASINS *

Classes of land	Area, sq. miles	Percentage of entire area	Saw-timber, M.b.f.
Above merchantable timber-line	17,573	82	....
Below merchantable timber-line—			
Area carrying 10,000 b.f. or more per acre	28	0·1	268,800
Area carrying between 5,000 and 10,000 b.f. per acre	298	1·4	1,430,400
Area carrying between 1,000 and 5,000 b.f. per acre	780	3·6	998,400
Area carrying young growth	1,749	8·1	....
Area incapable of carrying timber	1,066	4·8	....
Total	21,494	....	2,697,600

This table shows that 82 per cent of the area is above the line of merchantable timber. The altitude of this line varies for the most part between 1,500 feet and 3,000 feet. The former figure applies along the lower Stikine, where the Coast climate prevails, and the latter applies in some places in the southern portion of the drainage basin. On the other hand, in the portion of the region situated in the drier portions of the interior, the merchantable timber-line occurs at an elevation of about 4,000 feet.

* Very rough estimate.

Of the 3,921 square miles below the merchantable timber-line, all but 1,066 square miles is considered capable of carrying timber. The timber growth that once partially covered the valleys of the region has been badly burned, and large areas are now covered with a second-growth of willow and poplar. Other areas are reproducing with lodgepole pine, with or without a mixture of white spruce. In places, there are patches where the soil conditions are too wet to support forest growth. The bottoms of the U-shaped valleys, at the headwaters of the Stikine, are swampy, but their slopes are clothed with a forest of spruce and alpine fir, extending up to timber-line.

Around Telegraph Creek, the climate is arid, and there are areas along the Stikine where the conditions are too dry to support tree growth, especially on southern exposures. Nevertheless, at a short distance from Telegraph Creek, at higher altitudes, and even along the river on northern exposures, there are patches of timber, mostly second growth.

Merchantable Timber

The amount of merchantable timber, by species, in the Stikine-Unuk drainage basins is as follows : Hemlock, 1,189,440 M.b.f.; balsam, 284,640 M.b.f.; spruce, 1,038,720 M.b.f.; lodgepole pine, 99,840 M.b.f.; cottonwood, 84,960 M.b.f.; total, 2,697,600 M.b.f.

Along the Unuk and the lower courses of the Stikine and the Iskut, where the coastal climate prevails, hemlock-Sitka spruce is the principal forest type. The flood plains of these rivers carry rather heavy stands of cottonwood. In the interior, the principal types are the white spruce-alpine fir and the lodgepole pine types. On the richer soils of the valleys of the plateau, groves of poplar and dense thickets of willow prevail wherever fires have completely destroyed the original forest growth.

There are no saw-mills within the region. In the days of the Yukon gold rush a saw-mill was operated near Telegraph Creek, which cut timber in a forest within a few miles of the town. A small portion of this forest is left, and is roughly estimated to have a stand of 3 M. feet to the acre. Most of the timber used at Telegraph Creek and Dease lake is either hewn or whip-sawn. The timber of the Unuk and lower Stikine rivers would be easily accessible were there a market for it. Telegraph Creek is at the head of navigation on Stikine river. For five or six months of the year the river can be navigated by shallow-draught steamers or motor-boats.

The small population of the region is supported by fur-trading, gold-mining, and big-game hunters. As stated in the discussion of the drainage basin of Dease river, placer gold mining is the chief industry around Dease lake. Telegraph Creek, being the head of navigation, is the supply station for the region around Dease lake and beyond. In the hunting season, Telegraph Creek is visited by parties of big-game hunters from various parts of the world.

Except for a small amount of hay and an inadequate supply of small fruits and vegetables, no agricultural products are raised. Yet with some effort a sufficient quantity of these products could be raised to supply the needs of the small population.

Taku River Drainage Basin

Position and Physical Features

The drainage basin lies between the Stikine drainage basin on the south and the Atlin region on the north. It contains portions of two physiographic units, namely, the slopes of the Coast mountains and the Yukon plateau. However, only a very small portion of the region lies within the plateau. Taku river, under the name of Nakina river, rises near the southern end of Teslin lake, has a general south-westerly course, crosses the Alaska boundary, and enters Taku inlet not far from Juneau, Alaska.

Taku river receives an important branch from the southeast, the Inklin river, which rises near the town of Telegraph Creek, and has a general north-west trend to its junction with the Taku. A northern branch, the Sloko, rises in Sloko lake, at the southern end of Altin lake, flows a short distance east, and then south to its junction with Taku river. The plateau portion of this region has a general altitude of 4,000 feet ; the Coast mountains are high and rugged and are covered with glaciers, some of which fill the small side valleys and reach nearly to the waters of the Taku.

The portion of this basin in British Columbia has a fairly wide U-shaped valley, which contains a comparatively heavy growth of timber. The timber line occurs at an altitude of about 1,500 to 2,000 feet.

The climate of the lower course of Taku river is influenced to some extent by its proximity to the Alaska coast, and is comparatively warm and moist. The plateau region is, however, dry and cold.

CLASSIFICATION OF LANDS, WITH AMOUNT OF STANDING TIMBER, IN THE TAKU RIVER DRAINAGE BASIN *

Classes of land	Area, sq. miles	Percentage of entire area	Saw-timber, M.b.f.
Above merchantable timber-line	6,213	88	....
Below merchantable timber-line—			
Area carrying 10,000 b.f. or more per acre	....	....	....
Area carrying between 5,000 and 10,000 b.f. per acre	34	·5	163,200
Area carrying between 1,000 and 5,000 b.f. per acre	78	1·1	100,000
Area carrying young growth	325	4·6	....
Area incapable of carrying timber	409	5·8	....
Total	7,059	....	263,200

Thus, 88 per cent of the area is above the line of merchantable timber. Of the 846 square miles below this line, 409 square miles is considered to be incapable of carrying timber. This area is composed of swamps, lakes, and badly burned patches which, not re-stocking, are covered with grass or willow growth, or are barren. The merchantable timber lies mostly along the lower course of the Taku, where the moist, comparatively warm climate of the Alaska coast exerts a favourable influence.

The amount of merchantable timber, by species, in the Taku River drainage basin is : Hemlock, 114,240 M.b.f.; balsam, 28,160 M.b.f.; spruce, 102,640

* Very rough estimate.

M.b.f.; lodgepole pine, 10,000 M.b.f.; cottonwood, 8,160 M.b.f.; total, 263,200 M.b.f.

The hemlock-Sitka spruce type, with cottonwood on the flood plains, occurs in the valley of the lower Taku. In the plateau portion of the region, the white spruce-alpine fir and lodgepole pine types are found. Poplar groves and areas covered with willows occur where fires have been severe.

Except for a few Indians, the region is entirely uninhabited. A railway has been projected from the mouth of Taku river to the Atlin region, but construction will presumably be delayed. Without such a railway, the mineral resources of the region will necessarily be very slow of development.

Drainage Basin of the Atlin Region

Position and Physical Features

This region comprises that portion of northwestern British Columbia which is situated between the axis of the Coast mountains on the west and the Dease River divide on the east. It lies between the 59th and 60th parallels of latitude. There are two contrasting types of topography in the district, the Coast mountains and the Yukon plateau.

The Coast mountains consist of rugged mountains, a considerable portion of which is covered with snow and ice throughout the year.

The Yukon plateau, to the east, consists of uplands and valleys. The uplands have a general elevation of between 4,000 and 5,000 feet, while the valleys range from 2,200 to 2,400 feet. The valleys are steep-walled, typically U-shaped depressions, and are partially occupied by lakes. Of these, Atlin lake is the largest in the province. Bennett, Tagish and Teslin lakes extend across the Yukon boundary line. All the streams of the region empty into these lakes, and the waters of the latter find their outlet through the Lewes river, a tributary of the Yukon.

Atlin (altitude 2,240 feet) has an annual precipitation of about 12 inches, one-half of which is in the form of snow. This total is the same as that at Kamloops, in the southern portion of the dry belt.

The temperature conditions throughout the entire region are severe, even in the valleys. Atlin has a mean annual temperature of 30°, with a winter mean of 6·5° and a summer mean of 51°; the highest recorded temperature is 81° and the lowest −50°. Summer frosts are frequent. The severity of this climate will be more evident when compared with Kamloops, the mean annual temperature for which is 47°, winter mean 26°, summer mean 67°, highest recorded temperature 102°, lowest recorded −31°. With the same total precipitation, but with much lower temperature, the climate of Atlin is favourable to forest growth, while that of Kamloops is not. This can be accounted for only on the supposition that, under the lower temperature conditions, the limited amount of moisture is conserved in the soil instead of being evaporated rapidly, and can thus be utilized by the trees. At Kamloops, the evaporation is so rapid that no tree growth can exist except along streams, where soil moisture is present.

CLASSIFICATION OF LANDS, WITH AMOUNT OF STANDING TIMBER, IN THE ATLIN DRAINAGE BASIN

Classes of land	Area, sq. miles	Percentage of entire area	Saw-timber, M.b.f.
Above merchantable timber-line	7,774	83	....
Below merchantable timber-line—			
Area carrying between 1,000 and 5,000 b.f. per acre	150	1·7	192,000
Area carrying young growth	431	4·7	....
Area incapable of carrying timber	978	10·6	....
Total	9,333	....	192,000

Of the total area, 83 per cent lies above the line of merchantable timber, which here is between the contours of 3,000 and 3,500 feet. Of the 1,559 square miles below this line, 978 square miles is considered incapable of carrying timber. Of the latter, 596 square miles comprises the lake area of the region.

The amount of merchantable timber by species, in the Atlin Region drainage basin is: Balsam, 19,200 M.b.f.; spruce, 134,400 M.b.f.; lodgepole pine, 38,400 M.b.f.; total, 192,000 M.b.f.

The principal forest type of the region is the spruce-alpine fir. Lodgepole pine type occurs on the poor soils, where the original type has been badly burned. Poplar groves and willow thickets occupy the richer soils, where the original forest has been completely destroyed by fire.

Lumbering Operations

From the viewpoint of the coast or interior lumberman of southern British Columbia, the forests in the vicinity of Atlin would not be considered as containing merchantable timber. The character of the timber growth is comparable with that found at an altitude of 5,500 feet in the southern portion of the province. It consists mostly of white spruce, lodgepole pine and balsam. It is of small size and poor quality, and would be classed as non-merchantable were there any other available. Yet, around Atlin lake there are seven small mills, with an estimated output of 750 M.b.f. per year, all of which is consumed locally. Six of these mills are operated in connection with gold dredging companies, and the output is used for building flumes and other necessary construction. They are situated along streams tributary to Atlin lake. One of these mills is cutting spruce and balsam grown at an altitude of 3,300 feet.

The commercial mill at Atlin cuts its logs mostly from the easily accessible growth of forest, on the shores of the lake, at an altitude of about 2,200 feet. The best of the spruce timber averages two 12-foot logs to the tree, with a top diameter of 9 inches ; the best lodgepole pine will cut but one such 12-foot log per tree. The scarcity of this class of timber is shown by the fact that one logger claims that, to obtain 200 M. feet of logs, he scoured the shore of the lake for three miles, and for one-half mile back. Around Atlin lake, logs of this character are very scarce, and, in the near future, they will have to be obtained from less accessible sites, or else smaller logs will have to be used by the operators. It is estimated that, on the very best sites, the timber will average not more than 3 M. board feet to the acre, cut to an 8-inch diameter in

the top. This lumber sells for about $45 per M. at the mill. Due to high transportation rates, one small shipment of medium-sized bridge timber of Douglas fir from the coast cost $95 per M. feet laid down in Atlin.

Access to this region is obtained by rail from Skagway, Alaska, to Carcross, Yukon, situated on an arm of Tagish lake. From Carcross, the White Pass and Yukon Railway Company maintains, during the summer, a bi-weekly steamer service to a portage railway, four miles long, connecting Tagish lake with Atlin lake. A steamer plies between the terminus of the portage railway and Atlin.

The main industry of the region is placer gold mining. For a number of years, Atlin has produced a small but steady supply of gold. There are several ore mines, one of which is nearly developed to a commercial basis. The ore mining industry, however, must necessarily labour under a great handicap until better transportation facilities are available. Mention has already been made of the projected railway to connect Atlin direct with tide-water by way of the Taku (see page 318).

While a few vegetables are grown, no serious effort has been made to show what agricultural products can be raised. The soil and climate are capable of producing hardy vegetables in sufficient quantities to supply local needs. Some of the swamps grow fairly good hay, and cultivated forage crops can be raised. There is sufficient grazing land available to supply summer feed for the limited number of cattle that the small population needs. These grazing resources have not been utilized as yet.

Drainage Basins of the Alsek and Chilkat Rivers

Position and Physical Features

Reference to the key map will show that the extreme northwestern corner of the province is roughly triangular in shape. The pan-handle region of Alaska lies to the south, and Yukon to the north. The western portion of the region is crossed by the Alsek river, which flows south, draining into the Pacific. The middle portion of the region is drained by the Tatshenshini river, a tributary of the Alsek; the headwaters of the Chilkat drain the eastern portion.

This region is high and mountainous, and a large area is covered with glaciers. Very little is known about it or about the timber conditions.

CLASSIFICATION OF LANDS, WITH AMOUNT OF STANDING TIMBER, IN THE CHILKAT-ALSEK DRAINAGE BASINS *

Classes of land	Area, sq. miles	Percentage of entire area	Saw-timber, M.b.f.
Above merchantable timber-line	4,281	90	....
Below merchantable timber-line—			
Area carrying between 5,000 and 10,000 b.f. per acre	15	·4	72,000
Area carrying young growth	240	5·1	....
Area incapable of carrying timber	207	4·5	....
Total	[illegible],743	....	72,000

* Very rough estimate.

Of the area, 90 per cent is estimated to be above the merchantable timber-line, which is here situated at from 1,500 to 2,500 feet altitude. It is reported that there is 15 square miles of statutory timber on one of the tributaries of the Chilkat. This contains 72 million feet, of which 57·6 million feet is hemlock and 14·4 million feet is spruce. The Alsek valley, according to a forest map of Alaska, is shown to carry timber, but no information is available as to its amount or character. In the Klondike gold rush days, Chilkat pass, at the head of Chilkat river, was one of the routes leading to the gold-fields, and, at that time, most of the timber along this route was burned or was used for fuel.

A number of mineral claims are found in this region near where the timber limits are situated, and, if these mines should prove profitable, there is sufficient timber to develop them.

CHAPTER III

Forest Resources of the Coastal Belt of British Columbia

THE coastal region is that portion of the province lying to the west of the axes of the Cascade mountains and the Coast mountains, extending from the international boundary on the south to the watershed of Portland canal on the north. Several of the larger rivers emptying into the Pacific cut through the great mountain barrier, and the upper portions of their drainage areas are described in the preceding chapter, dealing with the interior of the province.

British Columbia has one of the most broken and uneven coasts in the world. John Burroughs* declares that, for 1,000 miles northward, from Victoria, the coast has "probably the finest scenery of the kind in the world that can be seen from the deck of a ship—scenery of fiords and mountain-locked bays and arms of the sea." It is dissected by countless inlets, channels or fiords, many of which run parallel with the coast, but others extend inland for from 50 to 100 miles between mountainous spurs of the main Coast mountains. To quote Mr. Burroughs again, "The edge of this part of the continent, for a thousand miles, has been broken into fragments, small and great, as by the stroke of some earth-cracking hammer, and into the openings and channels thus formed the sea flows freely, often at a depth of from one to two thousand feet."

Dr. J. W. Gregory, F.R.S., in *The Nature and Origin of Fiords*, 1913,† attributes the formation of the submerged, or partially submerged, valleys primarily to the folding of the earth's crust, which resulted in fissures and faults being formed. Subsequent stream action, following the faults which had produced planes of weakness where denudation was more rapid, has been an important factor. Glacial action, where present, has also been a powerful force in producing the typical U-shaped form which is so prevalent in these valleys.

A partially submerged range of mountains, known as the Vancouver Island mountains, which is represented above water by Vancouver island and the Queen Charlotte islands, affords protection to an extensive system of waterways. In addition to these large islands, there are numerous smaller ones, separated from each other and the mainland by navigable channels, so that coasting vessels can go from Vancouver to Skagway, a distance of over 900 miles, with only 35 miles of the course unprotected by islands.

It is estimated that the shore line of British Columbia exceeds 7,000 miles. This feature renders accessible, and facilitates the exploitation of, the timber

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* *Narrative of the Expedition*, Harriman Alaska Series, Vol. I, Smithsonian Issue, 1910, pp. 19-20.

† See footnote, p. 35.

and mineral resources of the region. The timber on the east side of Vancouver island, and on the mainland for a distance of 250 miles from the city of Vancouver, can be safely towed in open booms to the milling centres of Vancouver, New Westminster or Victoria for manufacture. Along the northern coast, similar conditions exist in regard to the timber tributary to Prince Rupert and the pulp-mills at Swanson Bay and Ocean Falls. If put up in cribs, logs can be transported with comparative safety from any portion of the coast to the manufacturing points. The west coast of Vancouver island presents most hazards in this connection.

The mainland and most of the adjacent islands are extremely mountainous. The shore-line is, as a rule, steep and rugged. The mountains on the mainland frequently rise to a height of from 5,000 to 6,000 feet within a mile or two of the water. Little flat land is to be found, except where alluvial deposits have formed at the mouths of the larger rivers or in the broad valleys which extend inland from the heads of the fiords. The delta of the Fraser river constitutes the largest area of such alluvial land.

Vancouver island is not so rough, though a range of mountains extends through the centre as far north as Beaver cove. Some of the peaks of this range attain altitudes of from 6,000 to 7,000 feet. Victoria peak attains an altitude of 7,484 feet. The north end of the island, above Nimpkish lake, and a strip from 10 to 20 miles wide along the eastern side, from Campbell river to Victoria, are comparatively level. The eastern portion of Graham island is quite flat, but its western portion and the greater portion of Moresby and other islands of the group are mountainous.

The agricultural land is confined largely to these more level areas, though there are many small patches of arable land where attempts are being made to establish 'ranches.' It is estimated that, throughout the coast, only 3,700 square miles, or 5·8 per cent of the total area, can be classified as agricultural. A considerable part of this land is still forested. No reliable data are available as to the amount of land at present under cultivation, but observations made in the various regions by the author indicate that not much more than 10 per cent, if that much, is in actual use for agriculture.

High Cost of Clearing

Clearing the land on the coast, where the forests are so heavy and the stumps so large, is a serious handicap to settlement, costing from $100 to $300 per acre. When operations are conducted on a large scale, and machinery is used to haul out the stumps, it can be done much cheaper. Development of the agricultural resources of the province is one of its most imperative needs. The province is largely dependent on imports for its food supply, and the resultant high prices are a distinct disadvantage in the development of other industries. A large increase in the rural population would materially assist in solving the labour problem, especially in the lumber industry. The promotion of agriculture requires, not increased alienation, but the development of the lands already granted. The government could assist in clearing, either by loans to settlers or by organized clearing under government control, the cost being chargeable against the land. Such action

would enable many struggling settlers to carry on agricultural operations at a profit, instead of at a loss, as is, at present, too frequently the case.

Settlement should be guided to districts where sufficient good land is available to support a community; thus ensuring the advantages of social intercourse, education and religion. The policy of allowing settlers to take up isolated land in a forested region is not fair to the settler and is a menace to the surrounding forests. A bona fide settler, who is willing to spend years of his life in turning the wilderness into a productive farm, is entitled to good land and congenial surroundings. The policy of placing the responsibility of settlement on the settlers, whose knowledge of the country is limited, cannot be justified. It is clearly the duty of the government, before opening an area for settlement, to ascertain by careful examination that it is suitable for settlement.

Subdivision of Coastal Belt

For the purpose of this report the coastal belt has been divided into five regions, within which the forest growth and the conditions of exploitation are similar. These regions have been further subdivided for descriptive purposes into 26 'drainage basins.' In determining the boundaries of these areas, the watersheds have been followed as far as possible, but, in some instances, the distribution of the forest types, the conditions offered for exploitation, or the administrative features have necessitated other divisions. For example, the Railway Belt, which is under the control of the Dominion Government, is described separately. Where their forest conditions are similar, several large drainage areas are grouped together.

The sub-division of the Coastal Belt has been made as follows :*

Southern Mainland Region—
- Railway Belt, Coast Section
- Chilliwack and Skagit Rivers
- Lillooet, Stave and Pitt Rivers
- Burrard Inlet and Howe Sound
- Jervis Inlet
- Powell River and Texada Island
- Toba Inlet
- Bute Inlet
- Loughborough Inlet
- Quadra to Hardwick Islands
- Knight Inlet
- Kingcome Inlet, Gilford Island
- Drury and Belize Inlets

Vancouver Island, East Coast Region—
- Hardy Bay
- Johnstone Strait
- South-eastern Section

Vancouver Island, West Coast Region—
- Renfrew District
- Barkley Sound
- Clayoquot Sound
- Nootka and Kyuquot Sounds
- Quatsino Sound

* See map showing drainage basins, facing p. 244.

Northern Mainland Coast Region—
Smith and Rivers Inlets
Burke and Dean Channels
Gardner Canal
Skeena River to Portland Canal

Queen Charlotte Islands Region—
Graham, Moresby and other Islands

Southern Mainland

The Southern Mainland region extends from the international boundary to Belize inlet, a distance of about 250 miles. The topography is generally rough and mountainous, 61 per cent of the area being above merchantable timber-line. It is protected by Vancouver island, and is well supplied by navigable waterways, on which the timber can all be towed to Vancouver or the other manufacturing centres in the southern portion of the province. It is in this region that most of the logging is now being done. The fire protection and other forest administration is conducted from the Vancouver office of the Provincial Forest Branch. The forests are chiefly of the Douglas fir-cedar type, but, in the northern portion above Knight inlet, the cedar-hemlock type predominates.

East Coast of Vancouver Island

The East Coast of Vancouver island, which is about 280 miles long, is tributary to the same milling centres as the southern mainland, and the forest conditions are very similar. Extensive logging operations have, for years, been carried on on this side of the island. The northern portion of this region is included in the Vancouver forest district for administration purposes, but the southern portion is under the Island district and is administered from the Victoria office.

West Coast of Vancouver Island

The West Coast of Vancouver island is indented with numerous inlets, which, in many instances, extend nearly to the centre of the island. Owing to the difficulty of towing in booms, on the open ocean, the lumber in this region will, for the most part, be manufactured locally. As yet, very little timber has been cut on the west coast. The Esquimalt and Nanaimo line to Alberni affords the only rail connection with the east side of the island. Lumbering operations are being conducted at Alberni. Some logging is also being done at the southern end in the vicinity of San Juan. Booms of logs can be towed from this point to Victoria, through the strait of Juan de Fuca.

Northern Mainland

The Northern Mainland Coast includes the mainland and adjacent islands from Queen Charlotte sound to the head of Portland canal. This portion of the coast is much cut up with inlets and is very mountainous; about two-thirds of the area is above merchantable timber-line, and a considerable portion of that below is not suitable for the production of commercial forests, on account of its rocky nature or the unfavourable climatic conditions. Along the shore line and in some of the larger valleys, however, there is a good forest growth, which is especially valuable for the manufacture of pulp. Hemlock predominates, and cedar, spruce and balsam are the other most important species. Douglas fir occurs only in

some situations near the heads of the inlets. This region, as well as the Queen Charlotte islands, is administered from the Prince Rupert office of the Forest Branch. Logs can be towed from any point north of Rivers inlet by inside channels to any other part of the region. Rail connection is afforded by the Grand Trunk Pacific railway at Prince Rupert and along the Skeena river and there are pulpmills at Ocean Falls and Swanson Bay.

Queen Charlotte Islands

The Queen Charlotte islands lie from 40 to 80 miles off the mainland, and, though logs can be towed across Hecate strait in cribs, the bulk of the timber will undoubtedly be manufactured locally. Hemlock, spruce and cedar are the most important species, and the pulp industry will be developed as a means of utilizing this timber.

Land Classification

An attempt has been made to classify the land in each drainage area, from the view-point of forest production. Accurate mapping of the whole area in the field was impossible, but, from the maps and other information available, supplemented by considerable personal inspection, the following classification has been made :

CLASSIFICATION OF THE LAND ON THE COAST
(Areas above and below merchantable timber-line)

Regions	Total area	Above merchantable timber-line		Below merchantable timber-line	
		Area	Per cent	Area	Per cent
	Sq. miles	Sq. miles		Sq. miles	
Southern Mainland	22,608	13,833	61	8,775	39
Vancouver Island, East Coast	6,615	826	12	5,789	88
Vancouver Island, West Coast	5,541	886	16	4,655	84
Northern Mainland Coast	25,616	16,886	66	8,730	34
Queen Charlotte Islands	3,784	284	8	3,500	92
Total	64,164	32,715	51	31,449	49

CLASSIFICATION OF THE LAND BELOW MERCHANTABLE TIMBER-LINE WITH RESPECT TO ITS CAPACITY TO BEAR TIMBER

Regions	Total area	Incapable of bearing saw-timber		Capable of bearing saw-timber		Agricultural land *	
		Area	Per cent	Area	Per cent	Area	Per cent
	Sq. miles	Sq. miles		Sq. miles		Sq. miles	
Southern Mainland	8,775	960	11	7,815	89	1,150	13
Vancouver Island, East Coast	5,789	224	4	5,565	96	880	15
Vancouver Island, West Coast	4,655	530	11	4,125	89	180	4
Northern Mainland Coast	8,730	3,870	44	4,860	56	190	2
Queen Charlotte Islands	3,500	1,570	45	1,930	55	1,300	37
Total	31,449	7,154	23	24,295	77	3,700	12

* Partially timbered.

CLASSIFICATION OF FOREST LAND*

Regions	Total area	Land carrying 30 M.b.f. or more per acre		Land carrying between 10 M. and 30 M.b.f. per acre		Land carrying less than 10 M.b.f. per acre, chiefly young growth	
		Area	Per cent	Area	Per cent	Area	Per cent
	Sq. miles	Sq. miles		Sq. miles		Sq. miles	
Southern Mainland	7,292	890	12	2,287	31	4,115	57
Vancouver Island, East Coast	5,340	1,350	25	1,700	32	2,290	43
Vancouver Island, West Coast	4,085	1,035	25	1,515	37	1,535	38
Northern Mainland Coast	4,810	230	5	1,400	29	3,180	66
Queen Charlotte Islands	1,920	335	18	620	32	965	50
Total	23,447	3,840	16	7,522	32	12,085	52

It will be seen that 51 per cent of the area is above the altitude at which merchantable timber grows. In the southern portion of the coast this merchantable timber-line is at an altitude of approximately 3,500 feet, though, as a matter of fact, very little good saw-material is found at over 2,500 feet. The timber-line becomes lower in the north, and, at Portland canal, merchantable saw-timber is seldom found above 1,500 feet.

Approximately 7,154 sq. miles, or 23 per cent, of the land below merchantable timber-line, or 11·1 per cent of the total land area of the coastal belt, is incapable of producing either agricultural crops or timber of commercial size. This land is chiefly steep or rocky, or is covered with muskeg which cannot be brought under cultivation. Of the total land area only 37·9 per cent, or 24,295 sq. miles, can be classified as productive, while 5·8 per cent, or 3,700 sq. miles, is estimated to be of value for agriculture, leaving only 32·1 per cent, or 20,595 sq. miles, as absolute forest land. As a considerable area of agricultural land is still under forest the present forest land is estimated to be 23,447 sq. miles, or 36·5 per cent of the total area. On over half of this area, however, the timber is not of commercial size, so that, on only 17·7 per cent of the area in the coastal belt are there forests which can be considered of commercial value. How much of this is accessible, and can be exploited profitably at the present time, is difficult to estimate, since so much depends on the changing price of logs, the development of transportation facilities and the opening up of adjoining timber.

Timber-land on the coast is defined by statute as that carrying 8,000 board feet or over per acre; but, in practice, land with less than 10,000 b.f. per acre is not considered worth operating, except under very exceptional conditions. The commercial or merchantable timber-land is divided into two classes, that carrying between 10 M.b.f. and 30 M.b.f. per acre and that carrying over 30 M.b.f. per acre. Roughly, the former includes two-thirds of the timber-land, the latter includes one-third. Of the forest land, 3,840 sq. miles, or 16·4 per cent,

* Does not include non-timbered agricultural land, town sites, etc.

carries over 30 M.b.f. per acre; 7,522 sq. miles, or 32·1 per cent, carries between 10 M.b.f., and 30 M.b.f.; and 12,085 sq. miles, or 51·5 per cent, carries less than 10 M.b.f. per acre, mostly young growth. Of the latter there is hope of it producing commercial forests within a period of time which can be considered in the present administration of the forests.

Estimate of the Amount of Standing Timber on the Coast

Owing to the variability of the stands of timber on the coast, it was found impossible to make a satisfactory estimate of the forest resources by applying wholesale methods of calculation. The roughness of the topography, and the variation in soil contents, cause the forest cover to change very quickly both in quantity and in species. On almost any well-timbered square mile, especially in the Douglas fir-cedar type, the stand will vary from zero to over 100 M.b.f. per acre. The composition of the stand may vary also, from spruce and cedar in the bottom land, through pure Douglas fir, to hemlock and balsam at the higher altitudes. Careful cruises* of 84 typical timber licenses of, nominally, 640 acres each, scattered throughout the southern coastal region, were obtained. When the licenses were surveyed they only averaged 616 acres in area and only 504 acres of merchantable timber. In only two instances was the whole area timbered. Since the two main factors, area timbered and average stand per acre, are quantities of such uncertainty, an estimate, to be of value, could be based only on detailed information.

Methods of Securing Information

It was naturally out of the question for the Commission of Conservation to undertake the field work necessary to obtain the required data. The timber on about 90 per cent of the merchantable timber-land had been alienated and, since the private owners, as a rule, have had their holdings cruised with more or less care, they were requested to furnish the Commission with details as to the amount and kinds of timber on their tracts. These reports were secured on the understanding that they would be treated as absolutely confidential. It is most gratifying to report that, with comparatively few exceptions, the timber-owners were most generous in their assistance. Much additional information was secured from timber-dealers, cruisers and others who had definite information concerning certain tracts. The Canadian Pacific railway, through its Forestry Branch, and the Land Department of the Esquimalt and Nanaimo railway contributed much valuable data. The results of a large number of forest reconnaissance surveys and land examinations were furnished by the Dominion Forestry Branch in connection with the lands in the Railway Belt and the Peace River Block, and by the Provincial Forest Branch as to lands throughout other portions of the province.

Cruisers' reports were thus secured on over 75 per cent of the alienated lands. Although quite a few had to be discarded as inaccurate, finally, reports on about 65 per cent of the alienated lands were accepted as a basis for estimating the total stands. Estimates were compiled for each of the drainage

* By Messrs. Clark and Lyford.

areas separately. These estimates were based upon such detailed cruises of lands in the district as were available.

Variations in Cruises

The cruising of standing timber is not an accurate science; it depends, to a large extent, on the judgment of the estimator, the object of the cruise and the standard adopted. As, in many instances, two or more cruises of one tract were secured, it was possible to form an opinion respecting the personal equation of the cruisers, which was taken into account when using their reports. Naturally, the earlier cruises were less detailed than the later ones, and, in most cases, were made simply to find out if there was sufficient timber to justify taking up the land. In most of such reports the smaller timber and the inferior species, such as hemlock and balsam, were omitted. Some of the cruises were unmistakably 'selling cruises,' and were discarded. It was found that the later and more thorough cruises, such as are now being made by the more scientific methods, were, as a rule, considerably higher than the earlier ones. This is due to the fact that they are made on a wood-volume basis and all the timber, including the inferior species and small sizes suitable only for piling, poles, pulp-wood, etc., is included. As yet, few cruises include timber under 10 inches on the stump; while, in most of the older cruises, 20 inches was considered the minimum diameter of merchantable timber.

There is considerable loss by breakage, which is unavoidable on rough, rocky ground; but this can be minimized by care in felling. Much of the best timber is consumed as fuel for the logging engines. The loss from these causes is sometimes, though not generally, discounted in the cruises. The proportion of the stand shown in a wood-volume cruise as utilizable depends, to a large extent, upon the care with which the tract is logged and the demands of the market.* As the cruiser has no control over these factors, it is his duty to report on the amount of wood which he finds on the land.

Under the methods of logging employed on the coast, much of the small material is destroyed during the felling and skidding of the large trees. The heavy machinery required for taking out the main stand is not adapted to the economical handling of the small timber. The prices procurable for this small material do not, under average conditions, justify the expense of logging, and, therefore, much of it is left in the woods. The development of the pulpwood industry has done much to encourage the utilization of hemlock and balsam; and, under certain circumstances, the demand for fir piling and cedar poles makes it profitable to take out this material, either with the main stand or at a later operation.

The estimate of the amount of saw-material on the coast includes all timber 14 inches or over in diameter, which may be utilized under reasonably conservative methods of exploitation. Since few of the cruises gave any report of the piling, poles, pulpwood, etc., the supplementary estimate of the small material was based on a relatively small amount of data. The estimate of this portion of the stand may be too low, but it is doubtful if even this amount will be utilized. (See table, page 242.)

* See page 185, Chap. VIII, Forest Exploitation.

ESTIMATED STAND OF SAW MATERIAL ON THE COAST

(Thousand feet, board measure)

Region	Douglas fir	Red cedar	Hemlock	Balsam	Spruce	White pine	Lodgepole pine	Yellow cypress	Cotton-wood	Total
Southern Mainland..........	18,596,190	23,189,060	10,453,795	4,969,540	1,196,860	320,670	18,605	854,455	58,565	59,657,740
Vancouver Island, East Coast.	31,360,130	12,336,190	10,409,030	4,523,030	704,890	479,930	1,610	1,201,490	....	61,016,300
Vancouver Island, West Coast	12,151,235	15,548,260	17,686,405	6,504,775	3,077,100	281,835	14,835	632,155	....	55,896,600
Northern Mainland Coast....	1,292,490	5,148,595	7,686,270	3,117,835	4,368,695	....	1,680	902,535	457,020	22,975,120
Queen Charlotte Islands......	....	3,727,100	5,712,700	....	4,817,800	....	31,000	465,100	....	14,753,700
Total..................	63,400,045	59,949,205	51,948,200	19,115,180	14,165,345	1,082,435	67,730	4,055,735	515,585	214,299,460

ESTIMATE OF THE AMOUNT OF PILING, POLES AND PULPWOOD ON THE COAST

Region	Piling and poles				Pulpwood					Total, piling poles, pulp-wood, etc.
	Douglas fir	Hemlock	Red cedar	Total	Spruce	Hemlock	Balsam	Total		
	M.b.f.	M.b.f.	M.b.f.	M.b.f.	M.b.f.	M.b.f.	M.b.f.	M.b.f.	Cords *	M.b.f.
Southern Mainland..........	745,000	405,000	1,685,000	2,835,000	66,000	728,000	470,000	1,264,000	1,805,500	4,099,000
Vancouver Island, East Coast.	900,000	320,000	755,000	1,975,000	48,000	540,000	530,000	1,118,000	1,585,800	3,093,000
Vancouver Island, West Coast	400,000	505,000	1,035,000	1,940,000	177,000	1,430,000	620,000	2,227,000	3,181,500	4,167,000
Northern Mainland Coast.....	35,000	370,000	480,000	885,000	630,000	1,140,000	240,000	2,010,000	2,871,400	2,895,000
Queen Charlotte Islands......	....	150,000	260,000	410,000	100,000	700,000	....	800,000	1,142,900	1,210,000
Total..................	2,080,000	1,750,000	4,215,000	8,045,000	1,021,000	4,538,000	1,860,000	7,419,000	10,587,100	15,464,000

* In British Columbia, 1 cord of pulpwood is taken as equivalent to 700 b.f.

ESTIMATED AMOUNT OF TIMBER ON THE COAST WHICH HAS BEEN ALIENATED UNDER THE VARIOUS FORMS OF TENURE

Tract	Area: Total	Area: Merchantable timber	Douglas fir	Red cedar	Hemlock	Balsam	Sitka spruce	Western white pine	Lodgepole pine	Yellow cypress	Cottonwood	Total
	Sq. miles	Sq. miles	M.b.f.	M.b.f.	M.b.f.	M.b.f.	M.b.f.	M.b.f.	M.b.f.	M.b.f.	M.b.f.	M.b.f.
Provincial timber licenses	* 7,000	6,000	19,843,100	36,678,600	35,464,700	13,324,300	9,651,100	526,100	39,900	3,410,700	344,700	119,283,200
Dominion timber licenses	527	380	3,736,000	2,915,000	1,292,000	310,000	82,000	47,000	1,000	52,000	15,000	8,450,000
Provincial timber leases	856	700	12,215,100	5,491,300	2,749,900	513,800	335,700	138,200	13,000	23,000	4,700	21,484,700
Provincial pulp leases	561	490	965,400	2,181,000	2,960,400	1,717,200	1,630,400	2,100	......	100,700	31,200	9,598,400
Crown grant	† 7,075	2,670	23,816,200	8,345,300	5,771,300	1,991,100	1,041,700	329,900	9,400	150,200	76,300	41,531,400
Provincial timber sales	38	20	51,900	104,600	80,900	28,700	1,400	700	......	300	....	268,500
Total	16,057	10,260	60,627,700	55,725,800	48,319,200	17,885,100	12,742,300	1,044,000	63,300	3,736,900	471,900	200,616,200

* Area estimated from the timber maps and includes some licenses which are not in good standing.

† Area estimated from the timber maps and includes applications to purchase and pre-emptions as well as lands actually Crown-granted.

On account of the high quality of the timber and its accessibility, a very large proportion of the total stand on the coast has been alienated. Approximately 60 per cent of the alienated timber is held under timber license; 20 per cent has been Crown granted; 11 per cent is under provincial lease; 4 per cent under Dominion license and 5 per cent under pulp lease. The percentage included in timber sales is, relatively, very small.

Under the heading 'Crown grant' in the table on page 331 are included lands held under application to purchase and pre-emptions for which Crown grants have not yet been issued. The areas of these alienated lands are, to a large extent, estimated from the timber maps issued by the Provincial Government, since definite data as to the areas were not available.

The Railway Belt, Coast Section

The Railway Belt consists of a strip of land extending 20 miles on each side of the main line of the Canadian Pacific railway, which, in the coastal region, follows the north bank of Fraser river. The Railway Belt terminates, on the west, at the North arm of Burrard inlet, and, on the south side, at a line running just to the east of New Westminster. This area is under the control of the Dominion Government in respect to the administration of the land and timber.

The Fraser river, in the lower portion of its course, traverses the Pacific system and, between the towns of Lytton and Yale, divides the Cascade mountains on the east from the Coast mountains on the west. A marked difference in the forest conditions is found in the region east of this portion of the Fraser as compared with the region west of it. The more arid conditions prevailing east of the Coast mountains result in the open, park-like stands, in which western yellow pine and Douglas fir predominate, with little or no cedar, spruce or balsam. On the Pacific side, the more abundant supply of moisture produces heavy stands of Douglas fir, red cedar and hemlock, with some spruce in the bottom-lands, and balsam at the higher altitudes. The most westerly point at which yellow pine is found in the Fraser valley is a few miles east of North Bend. On the Nahatlatch river, yellow pine is quite abundant on the east side, but is almost altogether absent on the west side.

From Lytton to Yale the valley is narrow, with high, steep mountains on both sides, forming what is known as the Fraser cañon. The forests on the mountain sides in this vicinity have, for the most part, been destroyed by fires. Much of this timber was destroyed during the construction of the Canadian Pacific railway. In some of the valleys lying behind the first lateral ridges, however, there are some stands of green timber which escaped destruction. Among these are the headwaters of Anderson, Nahatlatch and Spuzzum rivers. At Yale, the head of navigation on the Fraser river, the valley gradually broadens, and the flanking mountains, though badly burned, are less rugged and offer better forest sites. On the south side, the Cascade mountains terminate in Cheam mountain, near Chilliwack, and, from there westward to the gulf of Georgia, a distance of about 70 miles, there is a broad stretch of com-

paratively level ground, forming the delta of the Fraser. The elevation throughout this delta seldom exceeds 400 feet above sea level. When cleared, most of this area will be suitable for agriculture. With the exception of some low land, where prairie conditions exist, this valley bottom was once covered with a dense stand of fir, cedar and hemlock. Most of the present stand is of a relatively young growth, indicating that fires have swept the valley in the past and that this timber is a second growth. Lumbering has been very active in the Fraser valley for many years, and there are still about 30 saw and shingle mills in operation; these are fast using up all the merchantable timber. Though this land has almost all been Crown-granted, and settlers have been in possession for upwards of fifty years, only a very small proportion has, as yet, been brought under cultivation. The greater part of it is bush land, awaiting clearing.

Agriculture Not Progressing

Though supplied with excellent transportation facilities, by the British Columbia Electric, Canadian Northern, Great Northern, and the Canadian Pacific railways, agriculture is not making the progress it should, due, primarily, to the high land values which have prevailed. Many farms, on which a start was made, have fallen into the hands of loan companies, who advanced more money on them than the owners apparently thought the land was worth. The cost of clearing is a serious hindrance to cultivation, and Government assistance for this purpose may yet be found necessary if this valuable land is to be brought under cultivation. Very little of this land is absolute forest land, and should therefore be devoted to more productive uses. The soil and climate are suitable for fruit, garden produce, dairying and general farming. On the north side of the Fraser river, the agricultural land extends back from five to ten miles and, on the south side, it extends to the international boundary.

Five large lakes, Harrison, Stave, Alouette, Pitt and Coquitlam, drain into the Fraser on the north side, and the valleys in which they lie contain heavy stands of timber. Portions of these drainage areas are in the Railway Belt, the remainder being in provincial territory to the north.

Harrison lake is 40 miles long. Harrison river, only nine miles long, connects the lake with the Fraser, and is navigable by tugs during the high water season of five or six months. During this season, the logs can be taken in booms to the coast mills. Though as yet, there has not been much logging on Harrison lake, the feasibility of exploiting this timber has been demonstrated.

Stave lake is but nine miles long, and, though the upper Stave river drains a large area, the country is more rugged and the timber does not extend so far up the valley. Stave river is not navigable. A large fall, about three miles from the mouth, has been developed by the Western Power Company of Canada and is producing about 40,000 h.p. The electric power is used in the Fraser valley and in Vancouver and New Westminster. A short railway connects Stave lake with the Canadian Pacific railway and the Fraser river, and extensive logging operations have been conducted on the lake and along the

lower river for some years. Much of the most accessible timber has been cut. A large sawmill is situated at the mouth of Stave river.

Alouette lake, or Lillooet lake, as it was formerly known, is about ten miles long, and averages less than a mile in width. It drains into Pitt river, about five miles above the confluence of the latter with the Fraser. The drainage area of this lake is quite limited, but owing, perhaps, to the protection from fire afforded by Alouette river, which runs east and west, separating the more level and settled land from the timbered mountains, there is still an exceptionally heavy stand of timber in this valley; a considerable area carries from 30 to 75 M.b.f. per acre. Though some small operations have been conducted on the river and the logs driven to Pitt river, the main body of this timber is still in a virgin state.

Pitt lake is about sixteen miles long and from one to two miles wide, and the upper river drains a large area of provincial land. The sides of the lake are, for the most part, steep, rugged and badly burned, but there are several tributary valleys containing good stands. The timbered area extends along the upper Pitt river for about 20 miles; beyond that is a large area of rugged, glacial country, which provides a large flow of water in the summer. Pitt lake can be reached by tugs at all seasons of the year, and, being only seventeen miles from the milling centre of New Westminster, considerable logging has already been done on it.

Coquitlam lake, about eight miles long, with a tributary river over 10 miles long, occupies the next valley. The sides of this valley are rugged and badly burned. The lake furnishes the water supply of the city of New Westminster, and, to protect the watershed, it is surrounded by a reserve of 55,670 acres. The British Columbia Electric Railway Co. has erected a dam at the outlet of the lake, and diverts the water, through a tunnel, to its power station on the North arm of Burrard inlet.

Most of the merchantable timber in this valley is situated south of the lake, and practically no logging has been conducted except in this lower portion. The timber in this vicinity is very heavy, and the cedar is of high quality. Coquitlam river was used for driving logs in the early days, before the water was used for other purposes, but now a railway is used to take out the timber.

The Railway Belt includes the east side of the North arm of Burrard inlet, and the upper valley traversed by Indian river. The shore along Burrard inlet is very steep and rocky and the timber has been badly burned. Most of the merchantable timber has been removed, although there are still some shingle-bolt camps in operation. The timber in the valley of Indian river is very heavy in places and has not as yet been logged. Though a comparatively large river, it is not drivable for the large timber, and it is proposed to construct a flume to take out the logs.

On the low land along the banks of the Fraser, and on the islands scattered along its lower course, there is a considerable stand of cottonwood, estimated to be 42,780 M.b.f. This wood is used in the manufacture of boxes, carriage and automobile bodies and furniture, also for pulpwood.

CLASSIFICATION OF LANDS IN THE COASTAL PORTION OF THE RAILWAY BELT

Classes of land	Area, sq. miles	Percentage of entire area
Above merchantable timber-line	1,621	41·2
Below merchantable timber-line :		
Area carrying 30,000 b.f. or more per acre	190	4·8
Area carrying between 10,000 and 30,000 b.f. per acre	315	8·0
Area carrying less than 10,000 b.f. per acre (chiefly young growth)	1,472	37·5
Area incapable of carrying merchantable timber	40	1·0
Non-timbered agricultural land, townsites, etc.*	293	7·5
Total	3,931	....

In this portion of the Railway Belt, 720 sq. miles, or 18·3 per cent of the land area, is considered suitable for agriculture.

Estimate of Timber

The estimated amount of saw-material in this area is as follows: Douglas fir, 4,530,340 M.b.f.; red cedar, 3,431,060 M.b.f.; western hemlock, 1,540,320 M.b.f.; balsam, 387,460 M.b.f.; spruce, 90,200 M.b.f.; western white pine, 57,600 M.b.f.; lodgepole pine, 2,020 M.b.f.; yellow cypress, 65,120 M.b.f.; cottonwood, 42,780 M.b.f.; total, 10,146,900 M.b.f.

In addition to the timber suitable for the manufacture of lumber, there is estimated to be at least 535,000 M.b.f. of small timber which might be used for ties, piling, poles or pulpwood. Including all hemlock, balsam and spruce, there is about 3,375,000 cords suitable for the manufacture of pulp. If the cottonwood were so used it would add 60,000 cords to this total.†

Approximately 527 sq. miles, carrying 8,450,000 M.b.f., is held under Dominion timber licenses, and 1,096 sq. miles, with 910,700 M.b.f., has been permanently alienated. One provincial lease, of approximately 14 sq. miles, was granted prior to the transfer of the Railway Belt to the Dominion. The total area alienated is approximately 1,637 square miles. Situated close to the centres of population and the lumber industry, and well supplied by transportation on the Fraser river and by numerous railways, this timber is, on the whole, readily accessible, and will, doubtless, be exploited even more rapidly in the future than it has been in the past.

Forest fires have destroyed billions of feet of timber in this area; but, where the fires have not been too frequent and severe, excellent stands of reproduction are coming up. With proper protection it should be possible to sustain a cut of from 200 to 300 million feet per annum from the absolute forest land.

Provincial Land in the Skagit and Chilliwack Drainage Area

South and east of the Railway Belt and on the Pacific side of the Cascade mountains, there is an area of 358 square miles under provincial administration.

* This class includes lands which are capable of producing forests, and which, in large part, were, at one time, forested, but which are now, or are likely to be, devoted permanently to other than forest purposes.

† In British Columbia, 1 cord of pulpwood is assumed to be equivalent to 700 feet, board measure.

The western portion of this tract is drained by the Chilliwack river, a tributary of the Fraser, and the eastern portion by the Skagit river, which flows south through the state of Washington to Puget sound. The whole region is rough and mountainous, about 70 per cent of the area being above timber-line.

A waggon road has been constructed up the Chilliwack valley to within 12 miles of Chilliwack lake; above this point, there is only a trail. Little is known of the upper end of this valley, but it is reported that it contains some excellent cedar.

Skagit valley has no means of communication other than horse trails. Two of these traverse the valley from Princeton to Hope, and one follows the main river down to the settled district in Washington. At the international boundary, the valley bottom is perhaps a mile wide, gradually narrowing towards the headwaters. The mountain sides flanking the valley offer good forest sites, but fires have destroyed most of the merchantable timber. It is, however, being replaced with a thick pole-wood stand of fir, white pine, lodgepole pine and cedar. A good stand of virgin timber remains on the lower portion of the Klesilkwa river and also around the confluences of Skiast and Sumallo creeks with the Skagit. Most of the timber of commercial size has been taken up under license or purchase.

CLASSIFICATION OF LANDS IN THE CHILLIWACK AND SKAGIT DRAINAGE BASINS

Classes of land	Area, sq. miles	Percentage of entire area
Above merchantable timber-line	248	69·3
Below merchantable timber-line :		
Area carrying 30 M.b.f. or more per acre	3	·8
Area carrying between 10 and 30 M.b.f. per acre	19	5·3
Area carrying less than 10 M.b.f. per acre (chiefly young growth)	68	19·0
Area incapable of carrying merchantable timber	20	5·6
Total	358	....

There is reported to be but 6 square miles, or 1·7 per cent, of land suitable for agriculture in the Skagit valley.

Estimated Saw-material

Detailed cruises of the timber in the Chilliwack-Skagit area are not available, but, from the reports of several competent observers, the stand of saw-material is estimated to be approximately as follows : Douglas fir, 45,000 M.b.f.; red cedar, 125,000 M.b.f.; western hemlock, 25,000 M.b.f.; balsam, 12,000 M.b.f.; spruce, 5,000 M.b.f.; lodgepole pine, 6,000 M.b.f.; yellow cypress, 5,000 M.b.f.; making a total of 223,000 M.b.f.

In addition, there may be 50,000 M.b.f. of small timber suitable for piling, poles, pulpwood, etc. The total amount of timber suitable for the manufacture of pulp is probably about 90,000 cords. About 30 sq. miles has been taken up under timber license and some 7 sq. miles has been permanently alienated; total area alienated, 37 sq. miles.

Provincial Lands on the Lillooet, Stave and Pitt Drainage Basins

North of the Railway Belt a large area of provincial land is drained through the Lillooet, Stave and Pitt rivers, into the Fraser river. This area constitutes a natural forest resource unit. The Lillooet river, about 155 miles long, drains considerably over one-half of this area. It rises in a glacier between two ranges of the Coast mountains, and flows in a south-easterly direction into Harrison lake. The valley may be considered in four divisions, Harrison lake, lower Lillooet river, Lillooet lake and upper Lillooet river.

During high water in the summer months, Harrison lake can be reached from tide-water by small vessels, such as tugs. The lake, which is about 40 miles long, is navigable at all seasons of the year. Lower Lillooet river flows from Lillooet lake into Harrison lake, a distance of 30 miles. Though a large river, it is not navigable. When, in the early days, in order to avoid the Fraser cañon, this route was used in travelling to the Cariboo country, the Hudson's Bay Co. built a road along this portion of Lillooet river. During the 'seventies' it was used by the gold-seekers. Though the lower portion of this road has since been repaired and improved by a logging company, it is, as a whole, not much better than a trail. Lillooet lake is about 20 miles long and from one-half to one and one-half miles wide.

The valley of the upper Lillooet is about 60 miles long. In the lower 30 miles there is some very fine bottom-land, known as Pemberton meadows. This bottom-land averages about one and one-half miles in width, but, for seven miles above the lake, it is about two miles wide. Since the river is fed by glaciers, there is very high water in the spring, and it is sustained during June. As the outlet at the lower end of the lake is restricted, the water backs up and floods a considerable portion of the valley bottom. The damming up of the flood water has resulted in the building up of this flat, which is composed of rich alluvial silt. A large part of this area is open meadow-land and the remainder is comparatively easy to clear, the timber being small and chiefly cottonwood and willow. There is an old settlement here, but isolation from markets has prevented its development. The Pacific Great Eastern railway, under construction between Vancouver and Prince George, traverses the Lillooet valley at this point, and the agricultural resources, as well as the timber, will undoubtedly be developed.

On the upper reaches of the Lillooet the valley sides are well clothed with fir and cedar for a mile or two on each side of the river but, around Pemberton meadows, there is little or no merchantable timber. Up the Birkenhead river there is quite a good stand of timber, with a few hundred acres of agricultural land in the valley. The north-eastern side of Lillooet lake is very rocky and carries little merchantable timber, while on the opposite side there is only a narrow strip of timber along the shore. The Lower Lillooet river and several of its tributaries, such as Billy Goat, Glacier, Fire and Spring creeks, are well forested with fir, cedar, and hemlock; but, speaking generally, the timber is reported to be not of the best quality, especially the cedar, which is inclined to be rough and hollow.

On the north side there is a pass, by Twentythree-mile creek, through to the Nahatlatch river. On the latter stream, near the Railway Belt line, there is a heavy stand of cedar.

The shores of Harrison lake are well forested for a mile or more back. Douglas fir predominates, with red cedar, hemlock and white pine intermixed. At the higher elevations, yellow cypress is quite abundant. On the western side, the tributary valleys of Five-mile and Coon creeks contain strips of timber a mile or more wide, extending a considerable distance back from the lake.

Some logging has been done on the shore limits on Harrison lake and for a short distance up the Lillooet river. An attempt was made a few years ago to drive the river; but the swiftness of the stream, especially during high water, rendered control of the logs difficult. It may be possible to overcome these difficulties and drive logs from Lillooet to Harrison lake, but a railway would probably be a more satisfactory means of transportation. There are no fixed rates for towing logs from Harrison lake to New Westminster, but it has been done at an average cost of $1.00 per M.b.f. Now that the Pacific Great Eastern is built to this point, the timber on the upper Lillooet is, from an exploitation standpoint, tributary to Howe sound. The upper portion of the river cannot be considered drivable, and a railway will likely be required to take out this timber.

Perpetual Ice Fields

Between Lillooet river and Howe sound there is an immense barren area, estimated at 250 sq. miles, which, except where the bare mountain tops protrude, is covered with perpetual ice fields. The mountains in this region reach an altitude of between 8,000 and 9,000 feet, and present some of the most wonderful alpine scenery in the Dominion. Though close to transportation, and comparatively easy of access, this region has been visited by very few persons, and has never been accurately mapped. The Chehalis, Stave and Pitt rivers rise in this field of perpetual ice.

The upper Stave river has three main branches, which meet not far from its mouth. The East branch is timbered up to Stump lake, somewhat over 10 miles. The Middle branch is not so long, but the West branch extends in a north-westerly direction between 25 and 30 miles. The lower portion of the West branch passes through a deep cañon, but above this the valley broadens out and carries a considerable stand of cedar, with some Douglas fir, hemlock, white pine and yellow cypress. Logging operations have been conducted on the lower part of the East branch, but the remainder of the area has not, as yet, been developed. Driving can be carried on for only a short distance on either branch, and railways or flumes will be necessary to exploit most of this timber.

Very little, if any, of the provincial land on the Stave River drainage is suitable for agriculture.

Pitt river is a large stream, extending 25 or 30 miles above the lake. High granite ridges flank the valley which is a little over a mile wide at the head of the lake. About six miles above the outlet it broadens out and the timber extends two or three miles on each side of the river. Timber limits have been staked for 20 miles up the river, and, in places, there are excellent stands of cedar.

The river has deposited so much silt at its mouth, at the north end of Pitt lake, that the islands formed thereby interfere with log driving, even where the river is not too swift and rough. Some logging operations have been conducted on the lower limits, but the great body of timber is still virgin.

At the north end of Pitt lake, there are some meadow-lands which are partially, if not wholly, submerged in the spring and early summer. Some of this land has been taken up by pre-emptions, but not much of it can be considered as of agricultural value.

CLASSIFICATION OF LANDS IN THE LILLOOET, STAVE AND PITT DRAINAGE BASINS

Classes of land	Area, sq. miles	Percentage of entire area
Above merchantable timber-line	2,167	66·7
Below merchantable timber-line :		
Area carrying 30,000 b.f. or more per acre	37	1·1
Area carrying between 10,000 and 30,000 b.f. per acre	258	7·9
Area carrying less than 10,000 b.f. per acre (chiefly young growth)	710	21·9
Area incapable of carrying merchantable timber	60	1·9
Non-timbered agricultural lands	15	·5
Total	3,247	....

It is estimated that 40 sq. miles of land in these valleys, or 1·2 per cent, may eventually be of agricultural value.

Estimates of Saw-material

The stand of saw-material is estimated to be as follows: Douglas fir, 2,526,815 M.b.f.; red cedar, 1,247,790 M.b.f.; hemlock, 465,635 M.b.f.; balsam, 229,695 M.b.f.; spruce, 4,500 M.b.f.; white pine, 137,130 M.b.f; lodgepole pine, 10,585 M.b.f.; yellow cypress, 45,250 M.b.f.; making a total of 4,667,400 M.b.f. To this may be added 205,000 M.b.f., which may be utilized for piling, poles and pulpwood. The greater portion of the timber, 3,901,400 M.b.f., is in the Lillooet valley. The total amount of wood suitable for pulpwood, including all sizes of suitable species, is estimated at 1,070,000 cords.

In this district, approximately 330 sq. miles is held under timber licenses, 37 sq. miles under timber leases, 0·6 sq. mile under timber sales, and 35 sq. miles has been, or is in process of being, Crown-granted. The total area alienated is, therefore, approximately 402 sq. miles.

Burrard Inlet and Howe Sound Drainage Basins

Burrard inlet is the most southerly fiord on the mainland of British Columbia. It penetrates the Coast mountains a distance of about 30 miles and includes the harbour of Vancouver. From the wide entrance to the harbour, which is known as English bay, the channel is restricted to less than 1,000 feet at the First narrows. Inside the narrows it broadens out to from one to three miles and forms one of the largest and most magnificent harbours in the world, being almost completely land-locked.

To the north of Burrard inlet the Coast mountains rise by comparatively gradual slopes to over 6,000 feet. To the south, where the city of Vancouver is built, the land is composed of an alluvial deposit, underlain by sedimentary rocks.

The North arm of Burrard inlet is flanked on both sides by steep, rocky mountains, 3,000 to 4,000 feet high. The upper portion of this valley is occupied by Indian river. Port Moody, the original terminus of the Canadian Pacific railway, is situated at the eastern end of the main inlet, with North Vancouver on the north side of the inlet opposite Vancouver. On the north side, emerging from the snow-clad mountains, are three large streams, Capilano, Lynn and Seymour creeks, from which the water supply for Vancouver and North Vancouver is secured.

The British Columbia Electric Railway Co., which supplies light and power to Vancouver and New Westminster, and operates all the electric railways in the Fraser delta, secures its power from lake Buntzen, on the east side of the North arm. As the run-off in this drainage proved insufficient, the supply was supplemented by water diverted from Coquitlam lake and carried to Buntzen lake by a tunnel through the intervening mountains.

Advent of Railway

Vancouver was a sawmill site before the advent of the Canadian Pacific Ry. in 1886; with the entry of the railway, it soon became the chief centre of lumber manufacture in the province, a distinction which it still retains. The shores of Burrard inlet were once clothed with a magnificent forest of fir and cedar, remnants of which are preserved in Stanley park, at the entrance to the harbour. The quality of cedar grown in this district is said to be unexcelled on the Pacific coast. As might be expected, most of the timber close to the water on the north side, and practically all between the inlet and Fraser river has been cut. There still remain, however, some valuable stands in the valleys on the north side and on the higher slopes, where not destroyed by fire.

Howe sound is the next inlet to the north of Burrard inlet and is thirty miles deep. In the lower portion there are several high, rocky islands, the most important of which are Anvil, Gambier, Keats, and Bowen. Squamish river falls in the head of the sound. About seven miles from tide-water, the Cheakamus river, which is almost as large as the main stream, joins the Squamish from the east. An extensive delta has been built up at the head of Howe sound, and, for about 30 miles along the Squamish, there is a stretch of bottom-land on each side varying from one-quarter to one mile wide, which can be, and, to some extent is being, used for agricultural purposes. A waggon road has been built up the Squamish about 20 miles, with a branch up the Cheakamus.

The Pacific Great Eastern railway, under construction from Vancouver to Prince George, follows the east shore of Howe sound and the Squamish river to its confluence with the Cheakamus. Thence, it follows the Cheakamus to its source, crosses the divide, 2,105 feet above sea, and follows down Green river to Pemberton meadows, on Lillooet river.

On the west side of the Squamish valley the Tantalus range of mountains rises abruptly to from 2,000 to 6,000 feet, affording a very limited forest area,

except in the transverse valleys of the Ashloo and the Elaho rivers. Dividing the Squamish and Cheakamus valleys is a spur of lower but rugged mountains, on the slopes and draws of which there is a good forest stand where it has not been destroyed by fire. On the eastern side of the valley there is a large block of heavily timbered land drained by the Mamquam and Chiki rivers. This timbered area extends up the Mamquam about sixteen miles and up the Chiki seven miles, and forms a continuous belt from north to south about fourteen miles long.

To the east of the Cheakamus is a high range of mountains, of which mount Garibaldi, 9,000 feet, is the most prominent peak. It is in this large alpine area that the Pitt and Stave rivers rise.

The portion of the Fraser delta lying to the west of the Railway Belt is included in this drainage area. This land is chiefly agricultural, and is one of the most productive portions of the province.

CLASSIFICATION OF LANDS IN THE BURRARD INLET AND HOWE SOUND DRAINAGE BASINS

Classes of land	Area, sq. miles	Percentage of entire area
Above merchantable timber-line	1,107	54·5
Below merchantable timber-line		
Area carrying 30,000 b.f. or more per acre	110	5·4
Area carrying between 10,000 and 30,000 b.f. per acre	140	6·9
Area carrying less than 10,000 b.f. per acre (chiefly young growth)	460	22·6
Area incapable of carrying merchantable timber	75	3·7
Non-timbered agricultural land, townsites, etc	140	6·9
Total	2,032	....

There is estimated to be 210 sq. miles of land (10·3 per cent of the total area) which is suitable for agriculture. The largest portion of this is in the delta of the Fraser river.

Available Saw-timber

Though within easy reach of the lumber manufacturers, and the scene of active logging for the last thirty years, there is still standing some 6,454,900 M.b.f. of commercial saw-timber, composed of the following amounts : Douglas fir, 1,820,300 M.b.f.; red cedar, 2,235,600 M.b.f.; hemlock, 1,209,600 M.b.f.; balsam, 989,800 M.b.f.; spruce, 47,500 M.b.f.; white pine, 39,000 M.b.f.; yellow cypress, 108,400 M.b.f.; cottonwood, 4,700 M.b.f., making a total of 6,454,900 M.b.f. There is estimated to be also about 395,000 M.b.f. of small material, suitable for piling, poles, pulp-wood and ties. Of the pulp-wood species there is perhaps 3,464,000 cords.

In this drainage basin, there has been alienated under timber licenses, approximately 310 sq. miles; under timber leases, 14 sq. miles; under timber sales, 1 sq. mile; and 207 sq. miles for which Crown grants have been granted or applied for. The total area alienated is, therefore, approximately 532 sq. miles.

The fir on Burrard inlet has largely been cut, but several cedar shingle bolt operations are still being conducted. A flume several miles in length was in use a long time to take out shingle bolts from the Capilano valley, and a railway to take out the timber on the upper part of the valley is now under construction. Since the water supply of Vancouver is obtained from this stream and Seymour creek, it is extremely regrettable that no provision has been made for the protection of the forests of their watersheds. The timber along the shore-line on Howe sound has, for the most part, been cut or burned. The operation of the Pacific Great Eastern Ry. will facilitate the exploitation of the timber in the Squamish and Cheakamus valleys.

The timber cut in this district has heretofore been manufactured in the sawmills at Vancouver; but, with the completion of the Pacific Great Eastern, affording rail connection with the prairie provinces, a large portion of the timber will doubtless be manufactured locally in mills established along the line. The plant of the British Columbia Sulphite Fibre Co. is situated at Mill creek, on the western side of Howe sound, and provides a market for spruce, hemlock and balsam. There is another pulp-mill at Port Mellon, also on the west side of Howe sound. This plant was built by the British Columbia Wood-pulp and Paper Co., but has been taken over by the Rainy River Pulp and Paper Co. The towage on logs from Howe sound to Vancouver is only 25 cents per M.b.f.

Forest fires, which appear to be the inevitable sequel to industrial development, have accompanied the logging and clearing operations in this district, and have destroyed a large amount of valuable timber. Fortunately, conditions are improving, due to the more vigilant protective service and to the education of the public.

Jervis Inlet Drainage Basin

Jervis inlet, with its tributary channels, forms one of the most extensive fiords on this coast, the total navigable waterway exceeding 85 miles in length. The main inlet, which averages about one and one-half miles in width, follows a zig-zag course in a general northerly direction for 35 miles. As frequently happens in these fiords, the outlet of the channel is divided by islands, the chief of which are Nelson and Hardy. Physiographically, the Seechelt peninsula might also be considered an island, for Seechelt inlet, which enters Jervis inlet about 12 miles from its mouth, extends back in a southerly direction almost to the strait of Georgia, a low portage of less than three-quarters of a mile dividing the two bodies of water. The present outlet of Seechelt inlet to the north is so narrow and choked with rocky islands that the tidal currents produce dangerous rapids and over-falls, which can be navigated with safety only at slack tide. The name 'Shookumchuck,' meaning 'strong water', which the Indians apply to these narrows, is well chosen. Branching off to the east from Seechelt inlet are two channels, Narrows arm and Salmon arm, which are ten and twelve miles in length, respectively. About seven miles from the head of Jervis inlet, Princess Louise inlet enters from the east, through

a narrow channel similar to the Shookumchuck. As the inlet is only about five miles long, the tidal currents are not so strong.

From Howe sound to Seechelt inlet the land rises by a gentle slope from the strait of Georgia to a height of from 2,000 to 3,000 feet. This slope is well covered with soil, and once carried magnificent forests of fir and cedar, remnants of which are still to be found at the higher altitudes. The land, for two or three miles back from the shore, has been logged and re-logged and burned till there is very little of the original stand left, but there is generally a good stand of reproduction to be found. Settlers are now taking up this land for agricultural purposes; and, though some of the soil is quite gravelly, it offers an opportunity for agricultural development. Seechelt peninsula and Nelson island, though presenting no very high altitudes, are rough in contour, the granite rocks of which they are composed being exposed in many places, or covered with a very thin layer of soil. On the benches and in pockets, where the soil has collected, heavy stands of timber are to be found. On the shallow soils the timber is of a smaller and rougher type.

Jervis inlet itself is characterized by very steep, rocky shores, the mountains increasing in height towards the head, where large glacial fields occur. Not infrequently the shore line rises precipitously for 2,000 or 3,000 feet. In the tributary valleys, the chief of which are Deserted river, Vancouver river and Britain creek, excellent stands of timber extend back for from six to ten miles, and in the smaller ravines and more gentle slopes cedar and fir of superior quality are to be found.

The drainage area of Jervis inlet is comparatively small, owing to the fact that the watersheds of the Powell and Squamish rivers encroach on it to the north. The terminal valley is occupied by the Squakaw river. Unlike most of the other terminal valleys, it is short and of relatively small importance from a timber standpoint, though a heavy stand extends up the valley for about five miles. As might be expected from the mountainous nature of the country, the proportion of waste land in this district is high and there is very little land of value for agriculture.

CLASSIFICATION OF LAND ON JERVIS INLET DRAINAGE BASIN

Classes of land	Area, sq. miles	Percentage of entire area
Above merchantable timber-line	914	55·6
Below merchantable timber-line :		
Area carrying 30,000 b.f. or more per acre	50	3·0
Area carrying between 10,000 and 30,000 b.f. per acre	305	18·6
Area carrying less than 10,000 b.f. per acre (chiefly young growth)	295	17·9
Area incapable of carrying merchantable timber	75	4·6
Non-timbered agricultural land	5	·3
Total	1,644	....

It is estimated that, in the drainage basin of Jervis inlet, there is only about 21 sq. miles of agricultural land, which represents only 1·2 per cent of the land area.

Estimate of Stand

Red cedar predominates on Jervis inlet, with fir, hemlock and balsam as subsidiary species. The total stand of saw-material is estimated to be as follows: Douglas fir, 2,411,800 M.b.f.; red cedar, 2,540,400 M.b.f.; hemlock, 904,000 M.b.f.; balsam, 465,600 M.b.f.; spruce, 37,700 M.b.f.; white pine, 12,000 M.b.f.; yellow cypress, 85,600 M.b.f.; making a total of 6,457,100 M.b.f. Piling, poles, pulpwood and other small material are estimated to amount to 472,000 M.b.f. in addition to the saw material. The total amount of wood suitable for the manufacture of pulp is placed at 2,185,000 cords.

In this district, about 320 sq. miles has been alienated under timber licenses, 38 sq. miles under timber lease, 4 sq. miles under pulp lease, 2 sq. miles under timber sales, and 50 sq. miles has either been Crown-granted or has been staked for pre-emption or purchase. The total area alienated is, therefore, approximately 414 square miles.

The quality of the timber, especially of the cedar, has attracted loggers for a number of years, in spite of the rather rough ground on which they have to operate. As a result, much of the more easily logged timber has been taken out. At the present time, however, there are perhaps a dozen logging camps in operation in this district, the logs being towed to Vancouver and New Westminster for manufacture. The towage charges from Jervis inlet average about 75 cents per thousand board feet. As yet none of the longer valleys have been opened up by logging railways or other means of transportation. Thus far, the logging has been conducted by means of donkey engines, and, in some places, by chutes. There are only two manufacturing plants in the district—a shingle mill, situated at the head of Salmon arm, and a brick plant, near the outlet of Jervis inlet.

Owing to the ruggedness of the topography the tracts of timber are separated into comparatively small areas. From a forest protection standpoint, this reduces the danger from the spread of forest fires, and, though many fires have occurred in that district, very little damage has been done to the virgin stand, except on the southern slope facing the strait of Georgia.

Powell River and Texada Island Drainage Basin

For purposes of description, the area described below includes the mainland, from the mouth of Jervis inlet to Homfray channel, and, in addition, Texada, Lasqueti, Harwood and Savary islands.

The most prominent physiographic feature of the mainland in this region is the large number of fresh water lakes. They occupy the same broad, U-shaped valleys as characterize the fiords. The first of these valleys is drained by Eagle river, which flows through a chain of three lakes, called the Gordon Pasha lakes. A terminal river of considerable size occupies the upper end of the valley. Emptying into the second Gordon Pasha lake from the north is Horseshoe river, draining Horseshoe, Nanton, Dodd, Lewis and Windsor lakes, which lie in a valley about 12 miles long. The next valley to the east is occupied by Haslam lake, which is seven miles long and which empties into Malaspina strait by a river of the same name, eight miles long.

Powell lake, which is one of the largest bodies of fresh water on the coast, is very similar to the salt water inlets. The lake comes to within one and one-quarter miles of the tide water. Powell river, which carries the discharge of the lake, falls nearly 125 feet about one-quarter mile from its mouth.

Powell lake has never been accurately delineated on any published map. It is about 30 miles long. Goat island, about half way down the lake, is about 10 miles long and 3 miles wide. Upper Powell river occupies the terminal valley, which extends for a considerable distance above the lake. Two tributaries enter Powell lake from the east side, Goat river and Loon creek, each of which flows from a lake of some size. No other streams of importance flow into the lake. The drainage to the west of Powell lake flows into Malaspina inlet.

From Thunder bay, on Jervis inlet, to Powell lake, a low and comparatively flat area extends back for from one to four miles from the shore. This is well covered with a drift deposit, consisting of finely stratified hard sands overlain by several feet of stony clay. As might be expected, a wonderful stand of fir, with cedar as a secondary species, was produced on this land. Much of this timber near tide-water has already been cut, and the more remote parts are now being exploited. When cleared, much of this land will be suitable for agriculture, as the southern exposure and the deep, though somewhat stony, soil offers favourable conditions, especially for fruit growing.

From Powell lake to the Indian reserve at Sliamen, somewhat similar conditions exist, though the granite bedrock outcrops more frequently, and the flat land does not extend so far back from the shore.

From Sliamen to point Sarah the country, though not mountainous, is very rough; pockets of soil occur among the rocky outcrops. An attempt to place settlers on this land has been somewhat of a failure, as the proportion of tillable land on a homestead is frequently too small to support a family.

Behind this stretch of level land the granite mountains rise somewhat abruptly, but not to very great heights, hardly any being above timber-line within 15 miles of the salt water. Snow-capped peaks do occur, however, farther north. A large proportion of this mountainous land has been rendered waste by forest fires and subsequent erosion of the soil, leaving only bare rocks on which new soil will have to be formed before the forest can be replaced.

Practically all the timber facing on Powell lake has been destroyed in this way. Only isolated patches on tributary ravines or at high altitudes have escaped; and, owing to the steepness of the shore, it is not likely that a merchantable stand of timber will be produced for several centuries. The origin of these fires is uncertain, as they occurred many years ago; the last one of any importance occurred about 17 years ago. It is estimated that at least 1,250,000 M. board feet of timber has been destroyed in the vicinity of Powell lake by fire. Isolated fires have occurred in the Gordon Pasha region and in Malaspina inlet, but the areas destroyed have been comparatively small. The deep soil and moderate rainfall (from 60 to 70 inches per year) is conducive

to the development of fir of particularly good quality, while, at the higher altitudes to the north, where the rainfall is somewhat heavier, cedar becomes predominant. One of the finest stands of yellow cypress on the southern coast is found at an elevation of about 2,500 feet, near the Gordon Pasha lakes.

This district is one of the chief centres of the logging industry on the coast at the present time, especially for fir operations. Several logging railways are in operation. These include one from Scow bay to the Gordon Pasha lakes, one from Lang bay towards Haslam lake, another from Myrtle point running several miles in a northerly direction, and also one from Powell lake to the sea.

The largest pulp and paper manufacturing plant in British Columbia is situated at the mouth of Powell river. This site was selected on account of the excellent water-power available. Since its completion, the plant has been operated steadily and is producing about 250 tons of paper per day.

The shore-line from Powell river to Homfray channel, including Malaspina inlet, has been pretty thoroughly logged over, except Theodosia arm, where a fine valley of virgin timber remains.

Texada island is composed chiefly of conglomerates and sandstone and not of the granite which is found on the adjacent mainland. Generally speaking, it is a rocky ridge, with shallow soil, producing a relatively inferior stand of timber, composed almost entirely of fir. Along the eastern side, and in a few sheltered places on the west side, fairly good stands of timber occur. Most of the timber is small in diameter and is especially suitable for piling. Towards the centre of the island, in the northern part, there is some agricultural land which is being developed, but the main industry of the island is copper mining, which centres about the town of Van Anda. A small sawmill is situated at this point.

Lasqueti island, which is situated near the southern end of Texada island, is of the same geological formation and presents practically the same forest conditions as Texada island. The land is more level, however, and quite a colony of settlers has been established, with encouraging results.

CLASSIFICATION OF LANDS IN THE POWELL LAKE AND TEXADA ISLAND DRAINAGE BASIN

Classes of land	Area, sq. miles	Percentage of entire area
Above merchantable timber-line	462	41·2
Below merchantable timber-line :		
Area carrying 30,000 b.f. or more per acre	70	6·2
Area carrying between 10,000 and 30,000 b.f. per acre	195	17·4
Area carrying less than 10,000 b.f. per acre (chiefly young growth)	270	24·1
Area incapable of carrying merchantable timber	110	9·8
Non-timbered agricultural land, townsites, etc	15	1·3
Total	1,122	....

Harwood and Savary islands, which lie about two miles from the mainland above Powell river, are of the same formation as the flat land to the east of Powell river, being composed of sand with a top layer of gravel. The former

is an Indian reserve and is still heavily timbered, while the latter has been developed as a summer resort on account of the excellent sandy beaches that surround the island.

The logs from this district are all towed to Vancouver for manufacture, the cost of towing being about 60 cents per M.b.f.

About 60 square miles, or 1·3 per cent of the land-area of this district, will be of value for agriculture, but, as yet, most of it is timbered.

Estimate of Timber

Little over 370 sq. miles has been alienated, about one-third of which has been, or is in process of being, permanently alienated. About 109 sq. miles has been taken up under timber leases, 130 sq. miles under special licenses and 3 sq. miles under timber sales. The high percentage of the area which has been Crown-granted or leased is due to the fact that the excellent quality of the timber and the accessible location attracted the early investors. Though this region has been exploited for the past 30 years, the following amount of saw-material is estimated to be still standing: Douglas fir, 2,575,360 M.b.f.; red cedar, 1,404,410 M.b.f.; hemlock, 517,760 M.b.f.; balsam, 201,940 M.b.f.; spruce, 36,660 M.b.f.; white pine, 16,010 M.b.f.; yellow cypress, 37,560 M.b.f., making a total of 4,789,700 M.b.f.

The additional small material suitable for piling, poles, pulpwood, etc., is estimated to be 312,000 M.b.f. Pulpwood forms a relatively small proportion of the stand in this district, there being only 1,169,000 cords of all the species which can be used for this purpose.

Toba Inlet Drainage Basin

Toba inlet, with its main outlet, Pryce channel, extends in a north-easterly direction about 35 miles. The Redonda islands and Raza island, and the mainland adjoining Toba inlet are of the typical Coast Mountains granitic formation. The mountains are steep and rugged, those on the mainland often being covered at their summits with perpetual snow and ice. A broad terminal valley, occupied by Toba river, extends for a distance of over 30 miles above the head of Toba inlet. The river is navigable for shallow draft boats for a distance of 15 to 20 miles, and is one of the very few rivers on the coast on which log driving can be conducted. Two main tributaries, the North fork and the Little Toba, drain areas of considerable size. Klite river flows into the head of the inlet from the north. These rivers rise in glacial fields, and, as a result, a large amount of silt is brought down by them; this has caused the formation of an extensive delta at the head of the inlet, and the salt water is discoloured by the silt for several miles. Several lateral valleys enter Toba inlet, and in these, as well as on the more gentle slopes, good stands of timber are found.

With the exception of a few pockets of soil on the Redonda islands, no agricultural land is to be found in this vicinity. As the bottom land of Toba valley is very sandy and subject to floods, it is not, at present, suitable for settlement purposes. After the timber in the valley is removed, and some expenditure is made on dyking and draining, it may be possible to develop a few square miles of land for agriculture in this valley.

CLASSIFICATION OF LANDS IN THE TOBA INLET DRAINAGE AREA

Classes of land	Area, sq. miles	Percentage of entire area
Above merchantable timber-line	1,202	76·0
Below merchantable timber-line :		
Area carrying 30,000 b.f. or more per acre	35	2·2
Area carrying between 10,000 and 30,000 b.f. per acre	105	6·6
Area carrying less than 10,000 b.f. per acre (chiefly young growth)	150	9·5
Area incapable of carrying merchantable timber	90	5·7
Total	1,582	....

There is only about 7 sq. miles in this district which can be considered as of value for agriculture, and practically all of this is more or less timbered.

Approximately 152 sq. miles in this district has been alienated; 110 sq. miles is held under timber licenses, 26 sq. miles under timber leases, 2 sq. miles under timber sales and 14 sq. miles has been Crown-granted or applied for.

Saw Timber Available

The total stand of saw-timber is approximately as follows : Douglas fir, 922,610 M.b.f.; red cedar, 768,270 M.b.f.; hemlock, 395,530 M.b.f.; balsam, 197,920 M.b.f.; spruce, 125,520 M.b.f. ; white pine, 3,020 M.b.f. ; yellow cypress, 7,530 M.b.f. ; making a total of 2,420,400 M.b.f.

To this may be added 140,000 M.b.f. for small material, such as piling, poles, pulpwood, etc. The total amount of pulp material, including all the hemlock, balsam and spruce, is estimated to be 1,113,000 cords.

The rainfall in this region varies from 80 to 100 inches per annum, which favours the production of cedar. On account of the comparatively shallow soil and more or less exposed situation, the fir on the Redonda islands does not attain the large sizes and soft texture which are to be found in more favourable situations, and hemlock forms a considerable portion of the stand. Farther up the inlet the quality of the timber improves. In the valley bottoms there is a considerable percentage of spruce which attains large sizes and is of good quality. At the higher altitudes, balsam and yellow cypress are found. Though fires have been of frequent occurrence, the precipitous nature of the shore-line has resulted in localizing the burns and no very large areas have been destroyed. Reproduction is generally well established on logged-off or burned areas. Hemlock usually predominates after logging, unless the young stand established under the original forest is destroyed. A good example of pure hemlock reproduction, established under a mature stand of fir and hemlock, is well illustrated in the plate facing page 108 taken on Redonda island.

For the last ten years or more, a number of small logging operations have been conducted in this district, chiefly around Redonda islands, and a considerable amount of the most accessible fir has been taken out. Some years ago, the timber along the edge of Toba river, for a distance of ten miles from the mouth, was logged under an old donkey license, and logs were successfully driven to salt water. As there are no mills in this district, the cut has to be

towed to Vancouver or other manufacturing points. The average towage charge from Toba inlet to Vancouver is 90 cents per M.b.f.

Bute Inlet Drainage Basin

Bute inlet presents the same orographical features as Toba inlet. The high mountains flanking the channel are composed of granite, and their sides are generally steep and in places even precipitous. The valley, of which Bute inlet forms the outlet, is one of the most extensive on the coast. It rises in the Interior system and cuts through the Coast mountains. The salt water extends up about 28 miles, beyond which the Homathko river, with its tributaries, drains an area 50 miles in length by 25 miles wide. The Homathko, though carrying a large amount of water, is so swift and so full of bars that it is not navigable for any distance, and it is doubtful if logs could be successfully driven on it without a heavy expenditure for improvements. About 20 miles from the mouth, the river flows through Waddington cañon, a narrow box cañon several miles long, the sides of which are so high that great difficulty is experienced in reaching the upper part of the valley.

The Southgate, a river of considerable size, flows in from the north-east and enters the inlet near the head of salt water. It drains a valley about 30 miles in length. The Salmon river falls in on the east side of Bute inlet, and about mid-length. On the west side the lateral valleys are all short and contain small streams.

Opposite the outlet of Bute inlet, the inside passage, between Vancouver island and the mainland, is blocked by islands, and a series of 'narrows,' in which the tidal currents are very strong, occurs in all the connecting channels between the strait of Georgia and Johnstone strait. Stuart island lies at the entrance to Bute inlet. East of the island the passage is wide enough to permit an easy entrance to the inlet; but, on the west and north sides, the Euclataw and Arran rapids occur.

The precipitation in this vicinity varies from 70 to 100 inches, decreasing towards the head of the inlet.

CLASSIFICATION OF LANDS IN THE BUTE INLET DRAINAGE BASIN

Classes of land	Area, sq. miles	Percentage of entire area
Above merchantable timber-line	2,318	89·2
Below merchantable timber-line :		
Area carrying 30,000 b.f. or more per acre	30	1·2
Area carrying between 10,000 and 30,000 b.f. per acre	75	2·9
Area carrying less than 10,000 b.f. per acre (chiefly young growth)	125	4·8
Area incapable of carrying merchantable timber	50	1·9
Total	2,598	....

The amount of agricultural land in this district is very limited, 5 square miles (0·1 per cent) being about all that, under existing conditions, could be so classified. Most of this is more or less timbered.

There is practically no agricultural land except in the terminal valley, where a considerable delta has been built up. This land, where not well timbered, is chiefly gravelly or sandy and subject to floods. Settlement, therefore, should not be encouraged, at least until the timber is removed. On both shores of Bute inlet large areas of timber have been destroyed by fire. On some of this burned-over land, where the underlying rock has not been washed too bare, good fir, cedar and hemlock reproduction has been established. The timber grown in this region is generally above the average in quality, the cedar being particularly good. In the valleys near the head of the inlet there is a considerable amount of Sitka spruce.

Approximately 113 sq. miles has been alienated in this district; 100 sq. miles under timber licenses, 2 sq. miles under timber leases, 1 sq. mile under timber sales and 10 sq. miles Crown-granted or staked for pre-emption or purchase. Logging operations have been conducted in Bute inlet for a number of years, but the following amount of saw-material is estimated to be still standing: Douglas fir, 616,710 M.b.f.; red cedar, 767,920 M.b.f.; hemlock, 172,395 M.b.f.; balsam, 97,925 M.b.f.; spruce, 125,450 M.b.f.; making a total of 1,780,400 M.b.f.

About 95,000 M.b.f. may be added for piling, poles, pulpwood, etc. The total amount of timber suitable for the manufacture of pulp is estimated to be 608,000 cords. No manufacturing is carried on in this region, and all the logs are towed to the milling centres below. The average cost of towing logs from this vicinity to Vancouver is about $1 per M.b.f.

Loughborough Inlet Drainage Basin

This district includes that portion of the mainland lying north of Cardero, Chancellor, Wellbore and Sunderland channels, extending from the entrance of Bute inlet to Port Neville. Loughborough inlet, which is the most prominent geographical feature in the district, extends in a northerly direction about 20 miles. The valley divides at the head of salt water, Mink river draining the eastern branch and Stafford river the northern. The latter valley almost joins Knight inlet at its source. Two small inlets, Frederick arm and Phillips arm, occur between Bute inlet and Loughborough inlet. Frederick arm and the Estero basin (a salt water lagoon situated at the head of the arm) occupy part of a through-valley connecting Bute inlet with Cardero channel. Phillips arm extends north about five miles, and a large terminal valley, occupied by Phillips river and lakes, extends for 18 miles above salt water. On the west side of Loughborough inlet, and about nine miles from the head, a through-valley extends in a south-westerly direction to Sunderland channel. The eastern portion of this valley is occupied by Heydon lake, which drains into Loughborough inlet and the western end by Topaze harbour. Several such valleys, all with a generally east and west course, occur in this district. As a rule excellent stands of timber are found in the unsubmerged portions of these through-valleys.

The precipitation in this district is between 100 and 110 inches, and the winters are considerably colder than farther south.

The general formation is the usual granitic rock of the Coast mountains. Mineralized areas have been discovered on Frederick arm, Phillips arm and on Thurlow island, and some development work has been conducted.

In spite of the steep contour, heavy stands of timber occur along the shore-line of all these inlets, extending back from one to two miles from the salt water or several miles in the ravines. There is practically no land of agricultural value in the district, though a few small patches of soil have afforded an excuse for some pre-emptions.

CLASSIFICATION OF LANDS IN THE LOUGHBOROUGH INLET DRAINAGE BASIN

Classes of land	Area, sq. miles	Percentage of entire area
Above merchantable timber-line	384	50·9
Below merchantable timber-line:		
Area carrying 30,000 b.f. or more per acre	55	7·3
Area carrying between 10,000 and 30,000 b.f. per acre	145	19·2
Area carrying less than 10,000 b.f. per acre (chiefly young growth)	110	14·6
Area incapable of carrying merchantable timber	60	8·0
Total	754	....

About 10 sq. miles (1·3 per cent) of the land in this district may be considered as having some prospective agricultural value. Most of it is at present classified under one or other of the forest types.

Cedar of High Quality

Cedar is the predominating species; climatic conditions seem to be particularly favourable to its growth, for the quality of the cedar grown in this district is considered above the average. Some good yellow cypress stands are found at the higher altitudes. In the country north of Sunderland channel, Douglas fir is perhaps the most important species, heavy growths of excellent quality being found in this district. The total stand of saw-timber is estimated to be as follows: Douglas fir, 1,037,025 M.b.f.; red cedar, 2,037,475 M.b.f.; hemlock, 784,725 M.b.f.; balsam, 495,175 M.b.f.; spruce, 91,625 M.b.f.; white pine, 23,625 M.b.f.; yellow cypress, 45,750 M.b.f.; making a total of 4,515,400 M.b.f.

To this may be added 320,000 M.b.f. of piling, poles, pulpwood, etc. The total amount of timber suitable for pulpwood is estimated to be 2,131,000 cords. Approximately 212 sq. miles in this district has been alienated under the following forms: special licenses, 160 sq. miles; leases, 33 sq. miles; timber sales, 4 sq. miles; Crown-granted or applied for, 5 sq. miles.

This district has probably escaped damage from forest fires to a greater extent than most of the lower mainland districts, though several large areas have been burned, chiefly after logging. The most extensive area on which the virgin timber has been burned is a tract of land lying north of port Neville. Reproduction on the burned and logged-over area is, as a general rule, well established. Logging has been carried on extensively for many years, owing to the accessibility and good quality of the timber. Practically all of the cut is towed to the mills in the southern centres for manufacture. The towage

charge to Vancouver is about $1 per M. A large shingle mill was operated for a short time on Loughborough inlet, and a few small sawmills have been operated at different times, but none was in operation in 1916.

Quadra to Hardwick Islands

Between the mainland and Vancouver island a series of smaller islands is formed by the numerous winding channels. Johnstone strait and Discovery passage, which skirt Vancouver island, comprise the main channel, connecting the strait of Georgia and Queen Charlotte sound, but several other navigable passages also connect these waters.

Geologically these islands belong to the Coast mountains, being chiefly granitic in formation. The names and approximate areas of the larger islands in this group are as follows :

Cortes islands, 48 sq. miles; Read island, 21 sq. miles; Quadra island, 100 sq. miles; Maurelle island, 20 sq. miles; Sonora island, 56 sq. miles; Upper Thurlow island, 33 sq. miles; Lower Thurlow island, 43 sq. miles; Hardwick island, 27 sq. miles.

The channels dividing these islands average about a mile in width, but are frequently narrowed to a few hundred yards, causing swift tidal currents. Vessels navigating between the strait of Georgia and Queen Charlotte sound are forced to pass through one or other of these narrows.

The islands themselves are mountainous, but none reaches over 3,000 feet in height, and, where soil conditions permit, they are well timbered to the summits. Mary and Hernando islands and part of Cortes island have been formed by glacial deposit and, therefore, offer conditions suitable for agriculture. Agricultural land occurs also on Quadra and Read islands, but very little is to be found in the islands to the north and west of the series of narrows.

CLASSIFICATION OF LANDS ON QUADRA TO HARDWICK ISLANDS

Classes of land	Area, sq. miles	Percentage of entire area
Above merchantable timber-line	2	·7
Below merchantable timber-line :		
Area carrying 30,000 b.f. or more per acre	30	9·9
Area carrying between 10,000 and 30,000 b.f. per acre	120	39·7
Area carrying less than 10,000 b.f. per acre (chiefly young growth)	102	33·8
Area incapable of carrying merchantable timber	40	13·2
Non-timbered agricultural or industrial lands	8	2·7
Total	302	....

The area of agricultural land is estimated to be about 20 sq. miles (6·6 per cent), of which over half is still more or less timbered.

The timber on these islands is chiefly fir, and most of it is of excellent quality. Though a large proportion of this area has been logged, the following amount of saw-timber is estimated to be still standing : Douglas fir, 1,388,460 M.b.f.; red cedar, 411,040 M.b.f.; hemlock, 425,100 M.b.f.; balsam, 49,160

M.b.f.; spruce, 7,080 M.b.f.; white pine, 9,000 M.b.f.; yellow cypress, 1,000 M.b.f.; making a total of 2,290,840 M.b.f. The amount of small material, suitable for piling, poles, pulpwood, etc., is estimated to be 135,000 M.b.f. It is estimated that the total amount of hemlock, balsam and spruce would make 752,000 cords of pulpwood.

Out of a total area of 193,280 acres, it is estimated that 239 sq. miles has been alienated, under the following forms: Permanently alienated, 84 sq. miles; special licenses, 110 sq. miles; leases, 39 sq. miles, and timber sales, 6 sq. miles.

A large number of logging camps are still in operation in this district, and one shingle mill is being operated at Green Point rapids. The towage charges from these islands to Vancouver vary from 75 cents to $1 per thousand feet, depending upon whether the camp is above or below the narrows.

Knight Inlet Drainage Basin

Knight inlet is one of the largest fiords on the coast. The salt water extends from Queen Charlotte sound, in an easterly direction 40 miles and, thence, in a northerly direction, 30 miles. Above this, the terminal valley occupied by the Klinaklini river extends for a distance of 80 miles, cutting through the Coast mountains from the Interior plateau. Turner, Cracroft and several other islands are in or near the entrance to the inlet. Owing to the similarity of silvicultural conditions, they are considered with the Kingcome Inlet drainage area.

To the south of Knight inlet and about two or three miles distant from it, a parallel inlet, named Call creek, extends about 13 miles. Knight inlet is, perhaps, the most rugged fiord to be found on the whole coast. The mountains on each side, especially on the northern half, are very high and precipitous, several peaks rising above 7,000 feet. Within seven miles of salt water, two huge glaciers discharge into the Klinaklini valley; large ice fields are also visible in all directions from the inlet. Except for the lower ten miles, the Klinaklini valley is very narrow, in many places confining the river to narrow box cañons. At the eastern end of the lower reach of Knight inlet a valley extends across to the head of Loughborough inlet. In this valley there is a considerable stand of timber. About three miles to the west of this point a broad, fan-shaped valley enters at Glendale cove. Martin, Tom Brown and Keogh lakes are situated in this valley and the surrounding land carries an excellent stand of timber. The shore-line along Call creek and the lower end of Knight inlet is for the most part timbered, though there are many rocky out-crops which are bare.

The climate in this locality is considerably more severe than even at Loughborough inlet. As a result, Douglas fir is almost eliminated from the stand, except in the Tom Brown Lake region, and yellow cypress grows down to the water's edge. The rainfall ranges from 120 inches at the outlet to about 80 inches at the head of the inlet.

Except for a small area of delta land at the mouth of the Klinaklini, and some few scattered areas along the shore, aggregating probably 1,000 acres, there is no land in this district of agricultural value.

CLASSIFICATION OF LANDS IN THE KNIGHT INLET DRAINAGE BASIN

Classes of land	Area, sq. miles	Percentage of entire area
Above merchantable timber-line	1,982	85·0
Below merchantable timber-line—		
Area carrying 30,000 b.f. or more per acre	40	1·7
Area carrying between 10,000 and 30,000 b.f. per acre	140	6·0
Area carrying less than 10,000 b.f. per acre (chiefly young growth)	130	5·6
Area incapable of carrying merchantable timber	40	1·7
Total	2,332	......

Call creek has been the scene of logging operations for some years, but very little has been done on Knight inlet, where the stand is still to a large extent virgin. The estimated amount of standing saw-timber in this district is as follows : Douglas fir, 606,260 M.b.f.; red cedar, 1,415,770 M.b.f.; hemlock, 732,760 M.b.f.; balsam, 287,730 M.b.f.; spruce, 80,750 M.b.f.; white pine, 5,540 M.b.f.; yellow cypress, 82,020 M.b.f.; cottonwood, 2,170 M.b.f.; a total of 3,213,000 M.b.f.

The small material, suitable for piling, poles, pulpwood, etc., is estimated to amount to an additional 245,000 M.b.f.

Of the species suitable for the manufacture of pulp there is estimated to be 1,709,000 cords. Approximately 181 sq. miles has been alienated, as follows : Permanently alienated, 4 sq. miles; timber licenses, 140 sq. miles; timber leases, 17 sq. miles; pulp leases, 14 sq. miles, and timber sales, 6 sq. miles.

As might be expected from the climatic conditions, red cedar predominates, with hemlock and balsam forming a larger percentage of the stand than is found in regions to the south. The cedar is generally of good quality, though in some places it is inclined to be rough. Owing particularly to the fact that lumbering and settlement have not been carried on extensively, and also to the dampness of the climate, the destruction from forest fires has not been very great in this district. There is sufficient evidence, however, to show that, in dry seasons, fires will run even in the green timber.

The saw-logs from this district are towed to mills in the vicinity of Vancouver, at a cost of approximately $1.25 per M. The pulp leases in this drainage basin belong to the Powell River Company. The pulp timber from these leases and most of the hemlock and balsam from the other lands, are taken to Powell River in the form of logs.

Kingcome Inlet Drainage Basin

The next large fiord to the west of Knight inlet is Kingcome inlet. It is 18 miles long and parallels very closely the east-and-west portion of the valley occupied by Knight inlet. The upper end of the valley, running north and south, is occupied by Kingcome river. Wakeman sound, a tributary fiord, six miles long, comes in from the north side. About ten miles from the entrance to Kingcome inlet a small narrow fiord, about eight miles long, called Mackenzie

sound, enters Sutlej channel. Numerous small inlets, such as Thompson sound, Bond sound, Kwatsi bay, Simoon sound and Belleisle sound, occupy separate valleys or portions of through-valleys which have not been entirely inundated. Between Knight inlet and Kingcome inlet, and around the outlet of the latter inlet, are a number of islands, separated by channels, forming an even more complicated system of waterways than occurs in the Quadra-Hardwick group. The principal islands in this group and their approximate areas are as follows :

Gilford island, 137 sq. miles ; Cracroft island, 68 sq. miles ; Broughton island, 53 sq. miles ; Turnour island, 23 sq. miles ; Harbledown island, 14 sq. miles; Hanson island, 7 sq. miles; Baker island, 6 sq. miles; Eden island, 5 sq. miles; Bonwick island, 4 sq. miles; Village island, 3 sq. miles.

In addition to the above islands, there are numerous smaller ones. The rock in this vicinity is of the usual Coast granitic formation, except small areas of shale and limestone on Hanson, Harbledown, Cracroft and Swanson islands. The topography of the mainland is similar to that of Knight inlet. High, snow-capped mountains, frequently over 5,000 feet in altitude, rise close to the shore-line. Except Gilford island, where several peaks exceed 3,000 feet, the elevations of the islands seldom exceed 2,000 feet.

The main terminal valleys in this area are those occupied by Kingcome river and Wakeman river, the former being about 25 miles long and the latter about 20 miles. The timbered area on Kingcome river averages about two miles in width, with a tributary on each side extending back eight to ten miles from the main river. On Wakeman river the timbered land averages somewhat broader towards its mouth, and, for the lower 15 miles, is about 2½ miles wide. With the exception of the high land on Gilford island, almost all of the area on the islands can be classified as absolute forest land. There are numerous small rocky areas on which forests do not grow, but which are too small to be estimated. On the deltas at the mouths of Kingcome and Wakeman rivers there is some land of agricultural value, aggregating perhaps 5,000 acres, but elsewhere in the district the amount of agricultural land is negligible.

CLASSIFICATION OF LANDS IN THE KINGCOME INLET DRAINAGE BASIN

Classes of land	Area, sq. miles	Percentage of entire area
Above merchantable timber-line	1,038	63·4
Below merchantable timber-line :		
Area carrying 30,000 b.f. or more per acre	90	5·5
Area carrying between 10,000 and 30,000 b.f. per acre	300	18·3
Area carrying less than 10,000 b.f. per acre (chiefly young growth)	116	7·1
Area incapable of carrying merchantable timber	90	5·5
Non-timbered agricultural land	4	·2
Total	1,638	....

There is about 8 sq. miles of land in this district which may be classified as agricultural land. About one-half of it is open land and the remainder is timbered.

The rainfall in this district is very heavy, averaging between 110 and 120 inches per annum. The temperature, though perhaps not quite so low as on Knight inlet, is nevertheless considerably cooler than the more southern portion of the Coast region. Consequently, Douglas fir is almost entirely absent, and nearly half the stand is composed of cedar. The amount of saw-timber of each species is estimated to be as follows : Douglas fir, 113,710 M.b.f.; red cedar, 4,017,225 M.b.f. ; hemlock, 2,253,970 M.b.f.; balsam, 1,041,035 M.b.f.; spruce, 366,375 M.b.f.; white pine, 17,745 M.b.f.; yellow cypress, 287,725 M.b.f.; cottonwood, 8,915 M.b.f.; a total of 8,106,700 M.b.f.

Cedar poles and small pulpwood form quite an important part of the stand in this drainage basin. The total amount of this material is estimated to be 775,000 M.b.f. The hemlock, balsam and spruce, if used for pulpwood, would amount to a total of 5,760,000 cords.

This district is the centre of the cedar production at the present time. Owing to the strong demand for cedar lumber and shingles, a large number of logging camps are now in operation. Though the cedar grows to large dimensions, it is not, as a rule, of as good quality as that grown in the vicinity of the strait of Georgia. The trees generally are shorter, and have a more pronounced taper. Over large areas, nearly all of the mature trees appear to be suffering from some disease (evidently fungus) which has caused the tops to die. The hemlock and balsam in this region are of good quality and find a market as pulpwood. The forests along the western and southern portions of the islands are exposed to considerable wind from Queen Charlotte sound, which influences the quality of the timber.

Forest fires have done some damage on these islands; but, taking the district as a whole, it has escaped serious destruction from this source. Owing to the thinness of the soil in many parts of this district, severe fires, especially if repeated, result in the rocks being so exposed that reproduction is impossible.

In this district about 405 sq. miles has been alienated : 7 sq. miles is included in Crown-grants, pre-emptions, etc., 280 sq. miles is held under timber licenses, 1 sq. mile under timber leases, 110 sq. miles under pulp leases, and 7 sq. miles under timber sales.

The logs from this district are all towed to the southern manufacturing points. In 1916, much of the cedar was exported to Puget Sound mills, owing to the higher prices offered by the United States mills. The cost of towing to Vancouver averages about $1.50 per M.

Drury and Belize Inlets Drainage Basin

On the north side of Queen Charlotte sound, and to the west of Broughton island, there is an area of comparatively low land, extending back for about 25 miles, which is very much cut up with inlets. Most of these inlets have an easterly and westerly direction. The most southerly of these is Drury inlet, which runs west about 12 miles, from near the north end of Broughton island almost to Blunden harbour on Queen Charlotte sound. The valley, however, bends sharply to the east and the salt water extends another five miles in what is known as Actæon sound. Beyond this it is occupied by the

fresh water of Huaskin lake, for a distance of nine miles. The eastern end of the lake reaches to within half a mile of salt water again at Kenneth pass. A salt water lagoon runs for about four miles northward from the head of Actæon sound, in a through-valley extending to Warner bay on Seymour inlet.

The next system of waterways opens directly into Queen Charlotte sound. Three long fiords, Seymour inlet, Nugent sound and Belize inlet, extend eastward from a common outlet. Seymour inlet is about 40 miles long, and several bays still further increase the length of shore-line. The chief of these are Frederick sound, Salmon arm, Maunsell bay, Warner bay, and a series of lagoons which almost connect with Blunden harbour and Drury inlet. About two miles to the north of Seymour inlet, Nugent sound runs in a parallel direction for about 13 miles. The upper end comes within one-quarter mile of Seymour inlet. Belize inlet also parallels Nugent sound and Seymour inlet for 26 miles at an average distance of four miles. Its upper end also nearly meets Seymour inlet. On the north side of this inlet, Alison sound and Mereworth sound extend in a northerly and easterly direction each for about twelve miles. It will be seen that, if this region had sunk to a slightly lower depth, a series of open channels surrounding islands would have been formed, rather than closed inlets, as at present. The only terminal valley of importance in this district is that of Seymour river, which runs in a northerly direction about twenty miles from the head of Seymour inlet.

A range of high mountains lies along the northern and eastern edge of this drainage area. Many of the peaks exceed 5,000 feet in altitude. The ordinary granitic formation prevails throughout the district. The hills dividing the inlets are rounded and, though heavily timbered along the shore-line, are frequently very sparsely timbered on their summits, due perhaps to the exposure to the winds from Queen Charlotte sound. The precipitation in this district is usually from about 110 to 120 inches per annum and the temperature is similar to that on Kingcome inlet.

Douglas fir is practically non-existent in this region, forming only 0·1 per cent of the stand. Over 60 per cent is red cedar, which, though large in size, usually tapers very quickly and does not yield as high a percentage of clear lumber as that grown in the vicinity of the strait of Georgia. As in the Kingcome Inlet basin, many dead-topped cedars are to be seen. In a general way, it may be said that, for a distance of one-half mile back from the shore-line of the inlets, the stand of timber will average over 30,000 b.f. per acre. For the next half mile it will run between 10,000 and 30,000 b.f. per acre. Beyond that, there is a scrubby growth of cedar and hemlock, which has no present commercial value. Exceptions to this rule occur in sheltered ravines or in situations where the soil is deeper.

On the shore of Queen Charlotte sound, there is a strip of land which has been taken up under pre-emptions and applications to purchase, presumably for agriculture. It is chiefly of an open muskeg nature.

In this district there is about 40 sq. miles of land which is considered to be of value for agriculture. It is chiefly of a muskeg nature and, on only about one-quarter of it, is there timber of any value.

CLASSIFICATION OF LANDS IN THE DRURY AND BELIZE INLETS DRAINAGE BASIN

Classes of land	Area, sq. miles	Percentage of entire area
Above merchantable timber-line	388	36.3
Below merchantable timber-line :		
Area carrying 30,000 b.f. or more per acre	150	14.0
Area carrying between 10,000 and 30,000 b.f. per acre	170	16.0
Area carrying less than 10,000 b.f. per acre (chiefly young growth)	120	11.2
Area incapable of carrying merchantable timber	210	19.7
Non-timbered agricultural land	30	2.8
Total	1,068	....

In all, about 339 sq. miles has been alienated in this district. About 63 sq. miles has been alienated permanently, through sales or pre-emptions; 270 sq. miles is held under special licenses and 6 sq. miles under timber sales.

The total stand of saw-material in this region is estimated to be as follows : Douglas fir, 1,800 M.b.f.; red cedar, 2,787,200 M.b.f.; hemlock, 1,027,000 M.b.f.; balsam, 514,000 M.b.f.; spruce, 178,500 M.b.f.; yellow cypress, 83,500 M.b.f.; a total of 4,592,000 M.b.f.

The piling, poles, pulpwood, etc., not included in the above, will perhaps amount to 420,000 M.b.f. Of the pulpwood species there is estimated to be 2,700,000 cords.

Very little damage from fire is reported in this region, due doubtless to the moist climate.

Owing to the demand for cedar, several logging operations are being conducted in this region, the logs being towed to Vancouver or Puget Sound points.

The towage charge to Vancouver is about $2.50 per M.

Hardy Bay Drainage Basin, Vancouver Island

The eastern side of the northern portion of Vancouver island, extending from cape Scott nearly to Nimpkish lake, is comparatively flat, the few elevations being low and rounded. Much of the land, especially towards the north-western end, is of a muskeg nature, covered with a stunted growth of timber. Where drainage is provided, such as along streams or close to the shore-line, better soil conditions and heavier stands of timber occur. The underlying rock, which is occasionally exposed, is metamorphic in character and composed chiefly of conglomerates and sandstone. Seams of coal occur in some places. Included in this district, are a number of islands in Queen Charlotte sound. The largest of these are: Malcolm island, 38 square miles; Nigei island, 31 square miles, and Hope island, 14 square miles. The shore-line from cape Scott to Shushartie bay is exposed to the open Pacific, and very little shelter is afforded for shipping, although, at the mouths of Cache creek and Nahwitti river, there are small bays which, at some seasons of the year, afford sufficient shelter for booming logs. Hardy bay, however, offers splendid harbour facilities, and will, doubtless, be a port of importance when

this part of the island is developed. A trail extends from Hardy bay to Quatsino sound on the west coast of Vancouver island. The distance across is only about 8 miles in a straight line, and the elevation is very low. It is quite feasible to transport lumber, mineral or other products from Quatsino sound to Vancouver by means of this route and the inside passage. By water, Hardy bay is about 230 miles from Vancouver. The Canadian Pacific and the Canadian Northern railways have announced plans of extending their Island lines to Hardy bay, but immediate construction of either line is not to be expected.

The precipitation in this district is heavy, frequently reaching 120 inches per annum. The temperature in the winter averages about 5° lower than at Victoria and the summer is slightly cooler. A fairly large proportion of the precipitation in the winter is in the form of snow.

As might be expected from the topography, there is a considerable area of land in this district which can be utilized for agriculture when the forests are removed. Scattered settlers have located along the shore on the north side, and, in the vicinity of cape Scott, most of the land has been taken up under pre-emption, the land having been reserved in 1907 for that purpose. As yet, however, no extensive agricultural development has taken place. Lack of transportation and the expense and difficulty of clearing the land has rendered settlement in this district an arduous undertaking. Some years ago, a settlement of Norwegians was established on Malcolm island and, though many of the original members of the settlement have left, considerable improvement has been accomplished.

CLASSIFICATION OF LANDS IN THE HARDY BAY DRAINAGE BASIN

Classes of land	Area, sq. miles	Percentage of entire area
Above merchantable timber-line	none	....
Below merchantable timber-line—		
Area carrying 30,000 b.f. or more per acre	30	4·9
Area carrying between 10,000 and 30.000 b.f. per acre	240	39·1
Area carrying less than 10,000 b.f. per acre (chiefly young growth)	240	39·1
Area incapable of carrying merchantable timber	84	13·7
Non-timbered agricultural land	20	3·2
Total	614	....

Over 60 per cent of the land in this portion of Vancouver island may be classed as agricultural, but, out of the 380 square miles so classified, 360 square miles is more or less timbered, and is included in one or other of the forest types.

The total stand of saw-material is estimated to be as follows : Douglas fir, 6,110 M.b.f.; red cedar, 1,520,170 M.b.f.; hemlock, 1,622,810 M.b.f.; balsam, 809,350 M.b.f.; spruce, 232,830 M.b.f.; white pine, 1,110 M.b.f.; lodgepole pine, 1,610 M.b.f.; yellow cypress, 185,010 M.b.f.; a total of 4,379,000 M.b.f.

In addition to the saw-material, there is a considerable amount of piling, poles, pulpwood, etc., which will, perhaps, total 360,000 M.b.f.

It will be seen from the above that this district is almost out of the range of Douglas fir and the forests are chiefly of a pulpwood type. If used for pulpwood, the hemlock, balsam and spruce should supply over 4,000,000 cords. Red cedar, which is generally distributed throughout this region, is inclined to be 'swell-butted' and 'limby' and is frequently hollow in the centre, except in well-drained situations.

Approximately 544 sq. miles has been alienated in this district. About 354 sq. miles has been taken up by purchase or pre-emption. For a large portion of this area the conditions have not yet been fulfilled nor the Crown-grants issued. About 190 sq. miles is held under timber license.

Forest fires have done considerable damage, though the virgin forests do not burn readily. This district, has, however, been visited by several heavy wind storms, and, on some fairly large areas, the forests have been blown down. The resulting debris has afforded conditions under which fire, when started, has burned so fiercely and gained such headway that it has in places spread to the adjoining green timber. In some situations, where the soil is thin, the fire has precluded the re-establishment of the forest; but, generally speaking, a good stand of hemlock and balsam reproduction is coming up. Logging operations have not been conducted on a large scale. A small saw-mill on Malcolm island has supplied a limited local market for logs and produces lumber for the needs of the settlers in the district. The cost of towing logs from Hardy bay to Vancouver is about $1.75 per M.

Johnstone Strait Drainage Basin

This district, which, for the want of a better name, is designated Johnstone Strait basin, extends from Nimpkish lake to Campbell river on Vancouver island, and includes the watersheds which drain into Johnstone strait and Discovery passage. The channel formed by these two bodies of water is the route generally followed by the coastwise shipping. Entering from Queen Charlotte sound, the channel gradually narrows to two miles opposite Hanson island, and to one mile opposite Hardwick and Thurlow islands. About seven miles north of Campbell river, the channel becomes contracted to only 700 yards and forms the Seymour narrows, through which dangerous tidal currents run. The remainder of Discovery passage is from one to two miles wide. Throughout the whole length of this channel comparatively strong tidal currents occur.

The chief watersheds of this district, commencing at the north, are those of Nimpkish, Bonanza, Tsi-itka, Adams, Salmon, Bear, and Campbell rivers. The coast-line for the most part is bold and rocky, small bays at the river mouths being the only indentations. Generally speaking, the mountains rise rather abruptly from the shore to a height of from 2,000 to 5,000 feet. They are, as a rule, well timbered except where burned over. South of Seymour narrows, the mountains recede from the shore, leaving along the front a considerable area of comparatively low and rolling country. Behind the mountains which skirt the shore, there are broad interior valleys and the

contour of the country becomes less rugged so that large continuous areas of forest land occur.

The climate of this district is less severe than farther north. Although the precipitation along Johnstone strait is reported to be about 120 inches per annum, it does not exceed 80 or 90 inches at Campbell river.

There is considerable land in the interior valleys in this region which can be developed agriculturally. The largest and most important area occurs in the valley of Salmon river, where a tract, approximately 30 miles long and from 1 to 3 miles wide, will be available for settlement when the timber is removed. Already some of the logged-off land has been taken up by settlers and the possibility of successfully growing fruit, vegetables and the ordinary farm crops has been demonstrated. More limited areas occur in the valleys of Nimpkish and Adams rivers and along the shore between Menzies bay and Campbell river.

CLASSIFICATION OF LANDS IN THE JOHNSTONE STRAIT DRAINAGE BASIN

Classes of land	Area, sq. miles	Percentage of entire area
Above merchantable timber-line	773	31·8
Below merchantable timber-line :		
Area carrying 30,000 b.f. or more per acre	420	17·3
Area carrying between 10,000 and 30,000 b.f. per acre	630	26·0
Area carrying less than 10,000 b.f. per acre (chiefly young growth)	515	21·2
Area incapable of carrying merchantable timber	75	3·1
Non-timbered agricultural land	15	·6
Total	2,428	....

Perhaps 75 square miles (3·1 per cent) of the area could be developed for agriculture, but at present about four-fifths of it is forested.

Douglas Fir-Red Cedar District

The forests in this region are typical of the Douglas fir-red cedar type, and, as a general rule, the timber grown in this district is of a very high grade. The total stand of saw-material is estimated to be as follows: Douglas fir, 10,831,020 M.b.f.; red cedar, 5,858,020 M.b.f.; hemlock, 5,934,220 M.b.f; balsam, 2,706,680 M.b.f.; spruce, 410,060 M.b.f.; white pine, 180,820 M.b.f.; yellow cypress, 1,016,480 M.b.f.; a total of 26,937,300 M.b.f.

The yellow cypress which grows at the higher altitudes in the southern portion of the coast attains a much larger size and is of very much better quality than that grown on the muskeg sites in northern British Columbia. Though, at present, it is difficult to reach, it will prove a valuable part of the stand when the logging facilities are extended. In addition to the saw-material there is estimated to be in the neighbourhood of 1,305,000 M.b.f. of small timber suitable for piling, poles, pulpwood, ties, etc.

The total amount of hemlock, balsam and spruce which could be used in the manufacture of pulp is estimated to be 14,000,000 cords.

The excellent quality of the timber, and the large areas available for logging in this district, have attracted the attention of lumbermen for the

last twenty years, and, as a result, approximately 1,018 sq. miles has been alienated in one form or another. Only 105 sq. miles has been permanently alienated, the remainder of 284 sq. miles is held under timber lease, 540 sq. miles under timber license and 89 sq. miles under pulp lease.

Forest fires have done considerable damage in this region, chiefly owing to the fact that logging operations have been conducted in this district, between Campbell river and Adams river, for a number of years, with the usual increased fire hazard pertaining to such operations. It may be said that, generally, the forests are reproducing satisfactorily where fires have occurred. Fir and cedar form a good percentage of the young stands, though, possibly, hemlock predominates. There are no mills in this district, but several large logging operations are being conducted. The logs are nearly all towed to Vancouver for manufacture. The cost of towing logs from this district to Vancouver varies from 90 cents from Campbell river to $1.25 from Nimpkish river.

South-eastern Section of Vancouver Island

This district includes all the land lying within the boundaries of the Esquimalt and Nanaimo Railway land grant, the adjoining land to the south and east in the vicinity of Victoria, and the islands adjacent to the eastern coast of Vancouver island. The Esquimalt and Nanaimo belt, as the land grant is locally known, was granted to the railway by British Columbia, in order to facilitate the financing of the line from the city of Victoria to the coal areas near Nanaimo. It includes a strip of land, along the eastern side of Vancouver island about 135 miles long and averaging 24 miles wide. Most of this area is tributary to the strait of Georgia, though a small portion drains towards the west coast. A comparatively flat area, varying from 5 to 15 miles in width, extends along the greater part of the shore-line, and, throughout the whole belt, there is a comparatively small area above timber-line.

The total area in the Esquimalt and Nanaimo belt is 3,297 square miles, of which 109 square miles is covered by lakes and rivers, leaving a total land area of 3,188 square miles. In addition to the belt, this district includes 385 square miles of land, nearly all of which has been permanently alienated.

The approximate areas of the principal portions of this part of the district, not included in the Esquimalt and Nanaimo belt, are as follows :

South end Vancouver island and Saanich peninsula, 219 sq. miles ; Salt Spring island, 69 sq. miles; Pender island, 12 sq. miles; Saturna island, 12 sq. miles; Mayne island, 9 sq. miles ; Galiano island, 21 sq. miles ; Valdes island, 9 sq. miles; Gabriola island, 19 sq. miles; Hornby island, 11 sq. miles; Denman island, 19 sq. miles.

Sheltered from the westerly winds, and lacking the high, snow-capped mountains, such as occur on the mainland, the climate in this district is the most equable in the province. The precipitation averages 18 inches in winter, 9 inches in the spring, 4 inches in the summer and 15 inches in the autumn, totalling 46 inches, as compared with 60 inches on the adjoining mainland. The mean temperature in the winter is 38°, spring 48°, summer 61°, and autumn 49°. These climatic conditions are particularly suitable for the

Douglas fir and cedar forests, and these species probably attain their maximum growth in this region. The climate is propitious also for agriculture, especially for fruit, vegetables, poultry and live stock. In this district, including the adjoining islands, there is estimated to be 425 square miles upon which agriculture could be conducted. Owing to the density of the forests, and the high cost of clearing the land, however, only a comparatively small portion of the arable land, estimated not to exceed 100 square miles, has been actually devoted to agriculture. However, with the removal of timber, large areas are being made available for settlement, and several agricultural centres are established. The most important of these are in the vicinity of Comox, Alberni, Nanaimo, Duncan and Saanich.

CLASSIFICATION OF LANDS IN THE SOUTHEASTERN SECTION OF VANCOUVER ISLAND

Classes of land	Area, sq. miles	Percentage of entire area
Above merchantable timber-line	53	1·5
Below merchantable timber-line :		
Area carrying 30,000 b.f. or more per acre	900	25·2
Area carrying between 10,000 and 30,000 b.f. per acre	830	23·2
Area carrying less than 10,000 b.f. per acre (chiefly young growth)	1,525	42·7
Area incapable of carrying merchantable timber	65	1·8
Non-timbered agricultural lands, townsites, etc.	200	5·6
Total	3,573	....

In the forests in this region, Douglas fir predominates, comprising over two-thirds of the standing timber. Stands exceeding 50,000 board feet per acre occur over considerable areas, and frequently over 100,000 board feet per acre is found on smaller tracts.

Practically all the land in this district has been permanently alienated from the Crown. Only a few parcels, aggregating about 30 sq. miles, situated on the outlying islands and in the vicinity of Sooke harbour, are unalienated. The total stand of saw-material in this district is estimated to be as follows : Douglas fir, 20,523,000 M.b.f.; red cedar, 4,958,000 M.b.f.; hemlock, 2,852,000 M.b.f.; balsam, 1,007,000 M.b.f.; spruce, 62,000 M.b.f.; white pine, 298,000 M.b.f.; a total of 29,700,000 M.b.f.

In addition to the saw-material there is estimated to be 1,428,000 M.b.f. of small material, about half of which is fir, suitable for piling or ties, and the remainder is made up of cedar poles and pulpwood. The pulpwood species form a relatively small proportion of the stand, but are estimated to represent 6,213,000 cords.

Though it cannot be considered as important from a timber standpoint, the occurrence of Garry oak, in the district extending from Victoria to as far north as the Comox valley, is of interest, since this is the only region in British Columbia where it is to be found.

The quality of the timber generally, and particularly of the fir, is excellent. Logging operations have been carried on for many years. At present,

large logging operations are being conducted near Campbell river, Comox, Chemainus and Cowichan lake; there are also numerous small camps in operation. Saw-mills are in operation at Courtenay, Nanoose, Ladysmith, Chemainus, Victoria, Alberni, and at several other points along the railway. Extensions of the Esquimalt and Nanaimo Ry. have been built to Cowichan lake, Alberni and Courtenay, which facilitate exploitation of the timber in these districts; the extension of the line to Campbell river in the near future is expected. The Canadian Northern Ry. has located a line from Victoria to Comox, *via* Cowichan lake, Alberni canal and Comox lake. This railway will tap a large amount of excellent timber which, at present, is accessible only from the west coast.

Renfrew District

This district includes all the west coast of Vancouver island lying between Nitinat lake and river and the Esquimalt and Nanaimo Ry. land grant. It borders on the strait of Juan du Fuca. Shipping from the Pacific ocean to the ports on Puget sound and the strait of Georgia enters by the strait, which is about 14 miles wide. Port San Juan is the only harbour and is the centre of development in this district. The country is comparatively low and even in contour, and is generally well timbered. Commencing at the east side, the main rivers draining this territory are Jordan river, Lost creek, Sombrio river, San Juan river, Gordon river, Walbran creek and Carmanah river. Much of the area will be suitable for agriculture when cleared, and settlement has for some years been developing in the San Juan valley. The climate is mild, with heavy precipitation—over 100 inches annually.

CLASSIFICATION OF LANDS IN RENFREW DISTRICT, VANCOUVER ISLAND

Classes of land	Area, sq. miles	Percentage of entire area
Above merchantable timber-line	none	....
Below merchantable timber-line :		
Area carrying 30,000 b.f. or more per acre	240	41·7
Area carrying between 10,000 and 30,000 b.f. per acre	170	29·6
Area carrying less than 10,000 b.f. per acre (chiefly young growth)	75	13·0
Area incapable of carrying merchantable timber	80	13·9
Non-timbered agricultural lands	10	1·8
Total	575	....

About 75 sq. miles (13 per cent) of the land in this district could be used for agriculture, but most of it is timbered at present.

Approximately 442 sq. miles in this district has been alienated; about 350 sq. miles is held under timber licenses, 16 sq. miles under timber leases, and 76 sq. miles under various forms of permanent alienations. The quantity of saw-timber is estimated to be as follows : Douglas fir, 4,279,125 M.b.f.; red cedar, 3,126,725 M.b.f.; hemlock, 3,425,500 M.b.f.; balsam, 555,250 M.b.f.;

spruce, 532,500 M.b.f.; white pine, 79,625 M.b.f.; yellow cypress, 62,875 M.b.f.; a total of 12,061,600 M.b.f.

There is also about 742,000 M.b.f. suitable for piling, poles, pulpwood, etc. The total pulp material in the district is estimated to be 7,000,000 cords. The quality of the timber is generally excellent, and heavy stands occur over considerable areas.

Forest fires have done some damage; but the district, as a whole, has escaped serious injury, and satisfactory reproduction is being established on the burned and cut-over lands. Owing to the proximity to Victoria, and the shelter afforded by the Olympic peninsula, logs can be towed with comparative safety from Port San Juan. Extensive logging operations have been conducted in this district for a number of years; but, as yet, the cutting has made very little impression on the forest resources.

Barkley Sound Drainage Basin

This district includes that area on the west coast of Vancouver island, outside of the Esquimalt and Nanaimo land grant, which drains into Barkley sound and extends as far east as Nitinat river.

Barkley sound is a wide, island-dotted bay, terminating in Alberni canal. The latter is a long narrow fiord, which extends about two-thirds across Vancouver island. Great Central and Sproat lakes drain into the head of Alberni canal, and Nahmint and Anderson lakes occupy large tributary valleys on its west side. Effingham and Pipestem inlets, two smaller fiords, enter Barkley sound from the north side. Nitinat lake, which empties into the Pacific through a river less than a mile long, extends north-easterly about 12 miles and averages a mile wide. The terminal valley extends over 20 miles beyond the head of the lake and provides a low pass to Cowichan lake. Between Nitinat lake and Alberni canal, the topography is less rugged than on the west side of the latter. Little of this area is above timber-line; but, on some of the more exposed situations, the timber is of such a scrubby nature that it cannot be considered as of commercial value. On the west side of Alberni canal, however, there are fairly high mountains, the summits of the higher peaks extending beyond timber-line. Close to the shore on Barkley sound, the forests, where exposed to the winds from the open ocean, are of an inferior type, being composed chiefly of scrubby cedar, hemlock and balsam. Farther inland, as in the vicinity of Great Central and Sproat lakes, some of the finest timber in British Columbia is to be found. This is a region of heavy precipitation and mild climate. The precipitation is over 110 inches on the coast, decreasing to approximately 70 inches at Port Alberni.

There is very little agricultural land outside of the Esquimalt and Nanaimo belt, except in the vicinity of Ucluelet arm, where a small settlement has been established.

From the data available it is estimated that the area suitable for agriculture is about 35 sq. miles, or 3·4 per cent of the total area.

CLASSIFICATION OF LANDS IN THE BARKLEY SOUND DRAINAGE BASIN

Classes of land	Area, sq. miles	Percentage of entire area
Above merchantable timber-line	120	11·5
Below merchantable timber-line :		
Area carrying 30,000 b.f. or more per acre	350	33·7
Area carrying between 10,000 and 30,000 b.f. per acre	310	29·8
Area carrying less than 10,000 b.f. per acre (chiefly young growth)	200	19·2
Area incapable of carrying merchantable timber	50	4·8
Non-timbered agricultural land, townsites, etc.	10	1·0
Total	1,040	....

The total stand of saw-material is estimated to be as follows : Douglas fir, 4,883,315 M.b.f.; red cedar, 4,009,985 M.b.f.; hemlock, 3,609,180 M.b.f.; balsam, 1,259,135 M.b.f.; spruce, 299,515 M.b.f.; white pine, 136,935 M.b.f.; yellow cypress, 136,935 M.b.f.; a total of 14,335,000 M.b.f.

Small material suitable for piling, poles, pulpwood, etc., is estimated at 925,000 M.b.f. Including the saw-timber of the pulpwood species, there is estimated to be 8,120,000 cords of pulpwood. In all about 702 sq. miles have been alienated in this drainage basin, approximately 570 sq. miles under timber licenses, 89 sq. miles under timber leases and 43 sq. miles have been Crown-granted or have been applied for.

Forest fires have done considerable damage along Alberni canal and in the region to the north; but, on most of the burned-over areas, good reproduction of hemlock and balsam, with some fir and cedar, is replacing the burned forests. Most of this timber will be manufactured at Alberni. Rail connection with the east side of the island is already provided by the Esquimalt and Nanaimo (Canadian Pacific) Ry., and the completion of the Canadian Northern line will make all the territory draining into Nitinat lake accessible. In 1916, there was one mill in operation at Alberni. Cars can be loaded at Alberni and transferred by ferry to Vancouver for eastern shipment. The freight rates on lumber shipments from Alberni to the Prairie Provinces are about 50 cents per M.b.f. higher than from Vancouver. This is not serious, however, considering the excellent quality of the timber in the district and the facility with which much of it can be logged. In the future, Alberni will become an important lumber manufacturing centre. It is advantageously situated for export trade when facilities for manufacturing and shipping the lumber are provided. It is possible to tow logs in cribs from Alberni canal to Victoria, about 125 miles, but the element of risk in taking the logs out in the open ocean is so great that it is doubtful if it would prove a profitable method of handling the cut.

Clayoquot Sound Drainage Basin

Northwest of Barkley sound, the west coast of Vancouver island is indented by a series of fiords, connected by through-valleys, which form the system of waterways known, collectively, as Clayoquot sound. On the east side of Clayoquot sound two large valleys are occupied by the fresh water of

Kennedy lake. Kennedy river, approximately five miles long, connects the lake with salt water. Tofino inlet, Warn bay, Bedwell sound, Herbert arm, Shelter arm and Sidney inlet are the salt water fiords which make up the sound. These extend back from 10 to 16 miles from the ocean shore-line. The principal islands in Clayoquot sound are Meares, 27 sq. miles; Vargas, 10 sq. miles and Flores, 46 sq. miles.

West of Sidney inlet is a broad bay, Hesquiat harbour, with Hesquiat lake occupying the terminal valley, which is naturally included in this district. The several entrances to Clayoquot sound are more or less dotted by small, rocky islands, which, however, will not seriously detract from its value as a harbour when properly charted.

The topography is generally rocky and steep, rising to high mountains along the inlets. A comparatively level area, two or three miles wide, extends along the shore from Ucluelet to the entrance of Clayoquot sound, a distance of 25 miles. A broad, sandy beach extends along most of this distance. The land adjoining the shore has been largely taken up for settlement purposes. Another level area occurs to the west of Hesquiat harbour, and a few small isolated areas have been pre-empted elsewhere in this district. This region has the heaviest precipitation on the west coast of the island, the average being 118 inches per annum. The mean temperature is somewhat higher than at the other points of observation on this side of the island. The result is that, except where exposed to the wind from the Pacific, the forests grow luxuriantly, and heavy stands of timber occur along the inlets and in the terminal valleys.

CLASSIFICATION OF LANDS IN THE CLAYOQUOT SOUND DRAINAGE BASIN

Classes of land	Area, sq. miles	Percentage of entire area
Above merchantable timber-line	110	11·0
Below merchantable timber-line :		
Area carrying 30,000 b.f. or more per acre	125	12·5
Area carrying between 10,000 and 30,000 b.f. per acre	315	31·5
Area carrying less than 10,000 b.f. per acre (chiefly young growth)	350	35·0
Area incapable of carrying merchantable timber	90	9·0
Non-timbered agricultural lands	10	1·0
Total	1,000	....

There is perhaps 20 square miles which could be used for agriculture, about one-half of which is at present more or less timbered.

Owing to the excessive rainfall, Douglas fir does not thrive in this district, and forms less than 4 per cent of the merchantable stand. Red cedar is the predominating species, forming nearly 50 per cent of the stand, and is of good average quality. The total stand of saw-material is estimated to be as follows: Douglas fir, 338,475 M.b.f.; red cedar, 4,229,050 M.b.f.; hemlock, 2,305,075 M.b.f.; balsam, 1,122,200 M.b.f.; spruce, 523,975 M.b.f.; white pine, 43,625 M.b.f.; lodgepole pine, 7,525 M.b.f.; yellow cypress, 205,075 M.b.f.; a total of 8,775,000 M.b.f.

There is also estimated to be 755,000 M.b.f. of small material, suitable for poles, piling, and pulpwood. Including all of the hemlock, balsam and spruce, 6,220,000 cords of pulpwood are available.

In this district, the timber on about 498 sq. miles has been alienated, 75 sq. miles by pre-emption or purchase, 330 sq. miles under timber licenses and about 93 sq. miles under timber leases.

Forest fires have not done such severe damage as in some other parts of the province, doubtless owing to the damp climate. At present the timber in this region is not being exploited. Some years ago, a large mill was erected at Mosquito harbour to manufacture cedar lumber for the export trade; but it did not meet with success, and has been shut down for a number of years. With the growth of the export trade, however, mills of this type will no doubt be profitably operated in Clayoquot sound. Rail connection in the near future with the eastern side of the island is not probable, and, for some time at least, the timber will have to depend upon shipping. The cost and risk of towing logs to the established milling centres at Victoria and Vancouver would appear to preclude that method of transportation.

Nootka and Kyuquot Sounds Drainage Basin

This region embraces three main inlets, Nootka sound, Esperanza inlet and Kyuquot sound. The two former are connected by Tahsis canal. Two fiords, Muchalat and Tlupana arms, enter Nootka sound. Zeballos, Espinosa and Port Eliza arms are three inlets tributary to Esperanza inlet. Tahsis arm and Kokshittle arm open into Kyuquot sound, to the west of which three small inlets, Malksope, Ououkinsh and Nasparte, open directly into the Pacific. Gold river occupies the large terminal valley at the head of Muchalat arm. A branch of Gold river provides a pass through to Campbell river, and, by the west branch, the headwaters of Nimpkish river can be reached. This route has been selected for the extension of the Esquimalt and Nanaimo Ry. Other passes to the Nimpkish drainage occur from the head of Zeballos arm and Tahsis arm.

Generally speaking, the topography of this country is decidedly rugged, though no very high altitudes are attained. The shores of the inlets are, for the most part, steep and rocky, the forest land being confined to draws or benches or to the larger tributary valleys. The southern half of Nootka island is comparatively level, and some of the land along the shore has been taken up by pre-emption or purchase.

The precipitation in this district is somewhat less than on Clayoquot sound, with the result that fir forms a larger percentage of the stand. The district is almost uninhabited by white men, and, though perhaps 10,000 acres may eventually be of agricultural value, there is practically no land being used for that purpose at present.

The total stand of saw-timber is estimated to be as follows : Douglas fir, 2,077,360 M.b.f.; red cedar, 2,422,900 M.b.f.; hemlock, 3,340,610 M.b.f.; balsam, 1,242,630 M.b.f.; spruce, 814,710 M.b.f.; white pine, 12,410 M.

b.f.; lodgepole pine, 7,310 M.b.f.; yellow cypress, 167,070 M.b.f.; a total of 10,085,000 M.b.f.

CLASSIFICATION OF LANDS IN THE NOOTKA AND KYUQUOT SOUNDS DRAINAGE BASIN

Classes of land	Area, sq. miles	Percentage of entire area
Above merchantable timber-line	616	31·5
Below merchantable timber-line :		
Area carrying 30,000 b.f. or more per acre	180	9·2
Area carrying between 10,000 and 30,000 b.f. per acre	300	15·3
Area carrying less than 10,000 b.f. per acre (chiefly young growth)	665	34·0
Area incapable of carrying merchantable timber	190	9·7
Non-timbered agricultural lands	5	·3
Total	1,956	....

There is also estimated to be 700,000 M.b.f. of small timber, suitable for poles, piling and pulpwood. Including the saw-material of the pulp species, there is approximately 8,450,000 cords of pulpwood.

Approximately 360 sq. miles has been alienated; about 260 sq. miles being held under timber licenses, 28 sq. miles under timber leases, and 72 sq. miles by pre-emption or purchase.

No attempts have been made to exploit the forests in this region, and consequently little damage has, as yet, been done by forest fires. The extension of the railway would materially aid in the utilization of the forests in the Nootka Sound district and branch lines to the other inlets would be feasible. The development of the forest industries will, however, depend chiefly upon the export trade.

Quatsino Sound Drainage Basin

This district includes the western watershed of the northern portion of Vancouver island. Nearly all of this area drains into the Quatsino sound. This fiord is approached from the ocean by a funnel-like bay, which narrows gradually to approximately one-half mile in width at the mouth of the inlet. The harbour then opens out to an average width of about two miles for a distance of 15 miles. A tributary fiord, the Southeast arm, is 14 miles long, and another valley, occupied by Victoria lake, Alice lake and Marble creek, parallels the Southeast arm to the east. The upper end of Quatsino sound, known as West arm, is a body of salt water 35 miles long and averaging a mile in width. It extends in an east-and-west direction almost parallel to the main sound, with which it is connected by a narrow strait. This extensive system of waterways, navigable for ocean-going vessels, renders accessible a large amount of timber. The hills in this region are low, seldom exceeding 2,000 feet above sea level and, for the most part, are forest-covered. On the west side of this district a large portion of the area is almost flat. The rocks along the shore of Quatsino sound are close to the surface and in some places a considerable amount of timber has been blown down by heavy gales which have

occurred in this vicinity. The annual precipitation in this region exceeds 110 inches, and the mean annual temperature is about 2° below that of Clayoquot sound.

There is estimated to be perhaps 25,000 acres which may be of value for agriculture. A settlement, chiefly of Norwegians, has been established on this sound for over 20 years. Thus far, owing to the difficulty of reaching a market, very little has been accomplished in the way of agriculture, but sufficient progress has been made to demonstrate that fruits and vegetables can be successfully grown. In the vicinity of Holberg, at the extremity of the West arm, a large amount of land has been taken up by settlers in the last few years. There is urgent need of good roads to facilitate development. The population is dependent almost altogether on a fortnightly boat service to Victoria *via* the west coast. By crossing the island to Hardy bay, connection can be secured with boats following the inside passage.*

Practically all of the land is covered with a forest growth. In the southern and eastern portions of the district the forests are very heavy, but, towards the west end, they are chiefly of a muskeg type, composed of a scrubby growth of hemlock, yellow cypress, red cedar and balsam.

CLASSIFICATION OF LANDS ON THE QUATSINO SOUND DRAINAGE BASIN

Classes of land	Area, sq. miles	Percentage of entire area
Above merchantable timber-line	40	4·1
Below merchantable timber-line :		
Area carrying 30,000 b.f. or more per acre	140	14·4
Area carrying between 10,000 and 30,000 b.f. per acre	420	43·3
Area carrying less than 10,000 b.f. per acre (chiefly young growth)	245	25·3
Area incapable of carrying merchantable timber	120	12·4
Non-timbered agricultural land	5	·5
Total	970	....

The timber is chiefly of the pulpwood type, hemlock and balsam predominating, with a considerable proportion of Sitka spruce. Douglas fir, which comprises only a little over 5 per cent of the stand, is confined to a narrow strip close to the shore of the sound, where good drainage is provided. Red cedar is generally distributed throughout the district.

The total stand of saw-material is estimated to be as follows : Douglas fir, 572,960 M.b.f.; red cedar, 1,759,600 M.b.f.; hemlock, 5,006,040 M.b.f.; balsam, 2,325,560 M.b.f.; spruce, 906,400 M.b.f.; white pine, 9,240 M.b.f.; yellow cypress, 60,200 M.b.f.; a total of 10,640,000 M.b.f.

There is also estimated to be 1,045,000 M.b.f. of small timber, suitable for poles, piling and pulpwood. Including all the saw-material suitable for manufacture of pulp, there is estimated to be 13,050,000 cords of pulpwood.

In this drainage basin, about 599 sq. miles has been alienated; approximately 102 sq. miles by pre-emption or purchase (Crown-grants have not yet been

* See description of Hardy Bay drainage basin.

issued for a considerable portion of this land), 87 sq. miles under pulp lease, and about 410 sq. miles under timber licenses.

The pulp leases were granted in 1904 and 1906, with the understanding that a pulp-mill would be constructed for their immediate utilization, but, until 1917, no attempt was made to establish the plant, with the exception of a small saw-mill, which was operated for a short time. The forest resources are, therefore, in a virgin state. Ample power and water supply for the operation of a pulp-mill can be secured from Marble creek, and a large plant is now being constructed; this will mean a great deal to the development of the region. Other industries are likely to follow, and the mineral and agricultural resources of Quatsino sound may also be developed.

Forest fires in this region were practically unknown until a few years ago, when a windfall near Quatsino Sound village became ignited. The fire attained such headway in this dry material that it swept across the Narrows and extended over a considerable area. These windfalls present the chief fire hazards in this district, and it is necessary to maintain a vigilant patrol during the dry season to prevent further outbreaks of fire.

Smith Sound and Rivers Inlet Drainage Basin

Smith sound and Rivers inlet open directly into the Pacific ocean, near the northern extremity of Vancouver island. The former runs in an easterly direction for a distance of 32 miles. About six miles south of Smith sound is a tributary valley, also running east and west, which is occupied by Long lake and Wyclees lagoon. Two small inlets, Boswell and Naysash, branch off from the north side of Smith sound. The valley, of which Rivers inlet forms the outlet, is one of the larger valleys penetrating the coast. The salt water, however, extends only about 30 miles inland. Beyond that, Owekano lake, which empties into the head of the inlet by a river about four miles long, fills the valley for another 26 miles. Chuckwalla and Kildalea rivers also enter the head of the inlet from the north-east and north. Machmell river occupies the main terminal valley at the head of the main reach of Owekano lake. An extension of the lake follows a tributary valley from the north. This valley is contracted in three places, so that a chain of lakes is produced. The Sheemahant river, which flows into the lower of these lakes, is a large stream about 20 miles in length. Neechantz river, which flows into Owekano lake from the south, near the mouth of Machmell river, heads in the same valley as Seymour river. Drainey inlet enters Rivers inlet on the south side, and is about 15 miles long. The upper end of Drainey inlet is connected by a through-valley with Owekano lake. A large valley, in which Moses inlet and Klyak river lie, enters on the north side of Rivers inlet, about ten miles from the head. Towards the heads of these inlets high mountain ranges, with numerous large glaciers, occur. Near the coast, the hills are lower, though of a rugged granitic formation.

The area of agricultural land in this portion of the coast will probably not exceed 9 or 10 sq. miles.

CLASSIFICATION OF LANDS IN THE SMITH SOUND AND RIVERS INLET DRAINAGE BASIN

Classes of land	Area, sq. miles	Percentage of entire area
Above merchantable timber-line	1,900	63·3
Below merchantable timber-line :		
Area carrying 30,000 b.f. or more per acre	70	2·3
Area carrying between 10,000 and 30,000 b.f. per acre	240	8·0
Area carrying less than 10,000 b.f. per acre (chiefly young growth)	590	19·7
Area incapable of carrying merchantable timber	200	6·7
Total	3,000	....

The average precipitation on the coast is reported to be between 120 and 130 inches per annum; but, at the head of Owekano lake, it is only 60 or 70 inches. This causes a marked difference in the forest types of the two localities. On the coast, cedar, hemlock, balsam and spruce prevail, while around Owekano lake, good stands of the Douglas fir-red cedar type are to be found. About one-half of the total stand is composed of the pulpwood species.

The total stand of saw-material is estimated to be as follows : Douglas fir, 255,190 M.b.f.; red cedar, 1,991,155 M.b.f.; hemlock, 1,033,700 M.b.f.; balsam, 499,410 M.b.f.; Sitka spruce, 488,440 M.b.f.; yellow cypress, 437,105 M.b.f.; a total of 4,705,000 M.b.f. To this may be added 425,000 M.b.f. for small timber, suitable for piling, poles, pulpwood, etc. The total amount of available pulpwood is estimated at 3,230,000 cords.

There are no timber leases in this drainage basin. About 310 sq. miles has been taken up under timber licenses and 15 sq. miles has been, or is being, permanently alienated; total, 325 sq. miles.

The timber close to the coast is, as might be expected, of rather poor quality. Much of the cedar is dead-topped, and the hemlock is of an inferior grade. Farther inland, the timber greatly improves in quality, and excellent cedar and fir are found on Owekano lake. Owing to the distance from Vancouver, and the extra hazard of towing the logs across the open water of Queen Charlotte sound, practically no lumber operations have, as yet, been conducted in this region. As the supply of easily available timber decreases in the more southern districts, the logs will undoubtedly be towed from this region in specially constructed rafts. The establishment of local mills will prove the best method of exploiting the forest resources of this district. Salmon canning is an important industry in Rivers inlet, and some hand-logging is done to supply logs for a small mill which manufactures box lumber, and also for fuel for the canneries.

Though forest fires have occurred in several places, the damage from this source has not been very large.

Burke and Dean Channels Drainage Basin

From Queen Charlotte sound to the head of Lynn canal there is a series of north-and-south channels running parallel to the Coast mountains. These chan-

nels, with their transverse passages, separate the islands of a chain which extends from 10 to 40 miles out from the mainland. Branching off from these north-and-south channels are two extensive systems of waterways, which penetrate the main Coastal range. The southern system is formed by Burke and Dean channels, which debouch into Fitzhugh sound, and which are connected by Labouchere channel, thus enclosing King island. The upper ten miles of salt water in the main terminal valley of Burke channel is called North Bentinck arm. Above this the Bellakula river extends for over 75 miles, completely traversing the Coast mountains. Dean river, which flows into the head of Dean channel, also rises in the Fraser plateau and cuts through the Coast mountains. South Bentinck arm, 12 miles long, enters Burke channel from the southeast. Kwatna inlet, a small tributary of Burke channel, about ten miles long, parallels the southeast side of Burke channel at a distance of about two miles. In addition to Dean river, a valley of considerable size, occupied by Kinsquit river, enters the head of Dean inlet from the north. Two tributary fiords, Cascade and Cousins inlets, enter from the north, opposite King island. At the head of Cousins inlet a short river with a considerable fall empties from Link lake. This excellent water-power is being used by the pulpmill at Ocean Falls owned by the Pacific Mills, Ltd.

The principal coastal islands adjacent to these channels, and included in this basin, with their approximate areas, are as follows :

Calvert island, 106 sq. miles ; Hecate island, 40 sq. miles ; Hunter island, 170 sq. miles; Spider island, 6 sq. miles; Goose island, 8 sq. miles; Campbell island, 62 sq. miles ; Denny island, 50 sq. miles ; Cunningham island, 46 sq. miles; Chatfield island, 28 sq. miles; Bardswell group, 45 sq. miles; Yeo island, 26 sq. miles; Lady island, 8 sq. miles; Dowager island, 25 sq. miles.

The geological formation in this district is of the usual granitic type. The sides of the inlets are steep and rocky, and the mountains increase in altitude towards the heads of the inlets. Near the coast, and more especially on the western exposures of the islands or mainland, a considerable proportion of the land is covered with a mossy growth, with patches of scrubby yellow cypress and hemlock in places. In the more sheltered situations, Sitka spruce, hemlock, red cedar and balsam stands of fair quality are produced. Towards the heads of the inlets and along the tributary valleys, the climatic conditions are more favourable to forest growth. Douglas fir forms an important part of the stand in South Bentinck arm, and the other species are of much better quality than where found near the coast.

This portion of the coast is subject to very heavy precipitation, the records showing that it reaches 140 inches on the coast, decreasing to about 50 inches at the heads of Burke and Dean channels. Heavy falls of snow occur in the winter. As a consequence of the severer climatic conditions, the timber-line is considerably lower here than in the district protected by Vancouver island.

A definite classification of the land and forests in this district is difficult to arrive at, owing to the fact that a great deal of the forest is composed of a stunted growth of cedar, hemlock, balsam and yellow cypress. Most of the

cedar in this type is dead-topped, and none of the stand can be expected to produce anything more valuable than fuel, posts, or small pulpwood. At the present time, these forests are of no commercial value. For the purpose of this report a great deal of this class of land may be considered waste land. Practically the only land of agricultural value in this basin is in the Bellakula valley, where, for the last 20 years, there has been some settlement, chiefly by Norwegians. This valley varies in width from three miles at tide-water to one-half mile at 40 miles up stream. As the mountains on either side are unusually steep and high, generally precipitous, all of the agricultural land is in the bottom of the valley. The chief drawback to the agricultural development of this district is the distance from suitable markets and the lack of transportation. A waggon road has been built, from the head of the inlet, for a distance of 50 miles up the valley, and, beyond that, a trail connects with the Cariboo road, *via* Chilcotin river.

CLASSIFICATION OF LANDS IN THE BURKE AND DEAN CHANNELS DRAINAGE BASIN

Classes of land	Area, sq. miles	Percentage of entire area
Above merchantable timber-line	4,483	63·8
Below merchantable timber-line :		
Area carrying 30,000 b.f. or more per acre	50	·7
Area carrying between 10,000 and 30,000 b.f. per acre	270	3·9
Area carrying less than 10,000 b.f. per acre (chiefly young growth)	940	13·4
Area incapable of carrying merchantable timber	1,270	18·1
Non-timbered agricultural lands	10	·1
Total	7,023	....

The area of agricultural land is estimated to be about 26 sq. miles, over half of which is more or less timbered.

The total amount of saw-material in this drainage basin is estimated to be as follows : Douglas fir, 1,037,300 M.b.f.; red cedar, 1,254,190 M.b.f.; hemlock, 1,117,545 M.b.f.; balsam, 410,205 M.b.f.; spruce, 757,405 M.b.f.; yellow cypress, 89,585 M.b.f.; Cottonwood, 18,860 M.b.f.; a total of 4,715,000 M.b.f. In addition, there is a considerable amount of small material. It is estimated that 600,000 M.b.f. may be of value for piling, poles, pulpwood, etc. Of the pulpwood species it is estimated that there is, in the aggregate, about 3,920,000 cords.

In this basin, approximately 418 sq. miles has been alienated, as follows: Permanent alienation, 103 sq. miles; timber licenses, 190 sq. miles; pulp leases, 125 sq. miles.

The pulp mill at Ocean Falls and the small saw mill situated at Namu, on Fitzhugh sound, are the only forest industries in this vicinity.

Logs have been towed successfully from Ocean Falls to Vancouver, in cribs bound together by wire rope; but, as the cost of towing this distance is about $3.00 per M., the bulk of the timber will be manufactured locally.

Gardner Canal Drainage Basin

A system of fiords, very similar to the Burke-Dean system, occurs about 100 miles to the north of the latter. The principal waterways in this system are Gardner canal and Douglas channel. The former extends in an easterly direction about 80 miles and the latter in a northerly and easterly direction for about 50 miles. Numerous cross channels and branches of the main channel enclose islands of considerable size. A series of narrow, north-and-south channels separate the coastal islands from the mainland, and afford a sheltered passage for coastwise shipping. The principal islands included in this district and their approximate areas are as folows :

Princess Royal island, 792 sq. miles; Pitt island, 560 sq. miles; McCauley island, 115 sq. miles; Banks island, 376 sq. miles; Hawkesbury island, 144 sq. miles; Anger island, 16 sq. miles; Gribbell island, 85 sq. miles; Farrant island, 34 sq. miles; Gil island, 75 sq. miles; Campania island, 48 sq. miles; Estevan island, 70 sq. miles ; Aristazable island, 164 sq. miles ; Sarah island, 31 sq. miles; Roderick island, 155 sq. miles; Swindle island, 91 sq. miles; Price island, 49 sq. miles.

Gardner canal and Douglas channel are flanked by rugged mountain ranges, which, throughout the greater part of the shore-line, rise abruptly for from 1,000 to 3,500 feet. The islands are also very rocky and mountainous.

Kitlobe river and lake occupy the terminal valley of Gardner canal. This valley is only about 20 or 30 miles long, and very little is known of its character. It is reported to contain considerable bottom-land, which may possibly be of agricultural value, and to carry a heavy stand of timber, composed chiefly of cottonwood. Kemano river enters Gardner canal on the north side, about 20 miles from the head of the canal. Several small bays occur on either side, but usually terminate abruptly in steep cirques. Near the head, Douglas channel divides into two branches, Kildala arm and Kitimat arm. At the head of Kildala arm there is a broad, well-timbered valley. On the west side the tributary valleys are short and end abruptly. One of the most extensive through-valleys on the coast extends from the head of Kitimat arm by way of Lakelse lake, across the Skeena river, up the Kitsumgallum river and down Tseux river to the Nass. It has a general width of bottom-land of between five and ten miles, and contains some excellent agricultural land. Settlements are being established in this valley at the head of Kitimat arm and on both sides of the Skeena river, where transportation facilities are afforded by the Grand Trunk Pacific Ry.

The heaviest precipitation on the coast of British Columbia occurs in this district, 170 inches having been recorded for Swanson bay. It decreases gradually to about 60 inches at the heads of Kitimat arm and Gardner canal. A large proportion of this precipitation falls in the form of snow during the winter.

A very large percentage of the area which is below the timber-line is covered with a mossy muskeg, interspersed with a scrubby growth of red cedar, yellow cypress and hemlock. Except in the larger valleys, the merchantable

timber is, as a general rule, confined to a strip along the shore extending back from one-quarter of a mile to a mile. The highest altitude at which red cedar, hemlock and balsam attain merchantable dimensions in this region is about 2,000 feet. The spruce usually does not occur at over 500 feet, though yellow cypress reaches 3,000 feet.

The same difficulty of classifying the timber, as was noted in regard to the Burke and Dean channels, occurs here and throughout the whole northern coast.

CLASSIFICATION OF LANDS ON GARDNER CANAL DRAINAGE BASIN

Classes of land	Area, sq. miles	Percentage of entire area
Above merchantable timber-line	5,928	70·3
Below merchantable timber-line :		
Area carrying 30,000 b.f. or more per acre	60	·7
Area carrying between 10,000 and 30,000 b.f. per acre	420	5·0
Area carrying less than 10,000 b.f. per acre (chiefly young growth)	715	8·5
Area incapable of carrying merchantable timber	1,300	15·4
Non-timbered agricultural land	5	·1
Total	8,428	....

The area of land suitable for agriculture in this district is estimated to be about 45 square miles, most of which is still forested.

In this drainage basin, approximately 577 sq. miles has been alienated in the following manner : Permanently alienated, 65 sq. miles; timber licenses, 380 sq. miles; pulp leases, 132 sq. miles.

Investigation shows the total stand of saw-timber in this district to be approximately as follows : Red cedar, 1,143,330 M.b.f.; hemlock, 2,458,755 M.b.f.; balsam, 1,101,420 M.b.f.; spruce, 1,454,610 M.b.f.; yellow cypress, 261,885 M.b.f.; cottonwood, 4,000 M.b.f.; making a total of 6,424,000 M.b.f. In addition there is estimated to be about 880,000 M.b.f. of small timber, suitable for piling, poles, pulpwood, etc.

Though Douglas fir does not figure in the stand as of commercial importance, it does occur at the head of Gardner canal, chiefly on the north side beginning at Kemano river and extending as far as Kitlobe lake. The precipitation in this locality is, as noted, only from 60 to 70 inches per annum. The bulk of the timber is of the species suitable for the manufacture of pulp, and can be best used for that purpose. Including all sizes, there is estimated to be about 8,260,000 cords of pulpwood in this district. The quality of the timber improves as one proceeds eastward along the inlets, and some excellent hemlock, balsam and spruce stands are to be found in the sheltered places protected from the damp winds from the coast.

Damage from fire is not so noticeable towards the coast; but, in the drier situations on Kitimat arm and along the upper 50 miles of Gardner canal, severe damage has been done. The rocks in many places have been so completely bared by the fire that successful reproduction is precluded.

The Swanson Bay pulpmill is situated on the mainland side of Graham reach, opposite Princess Royal island. To utilize the cedar and higher grades of spruce for lumber, a sawmill is operated in connection with the pulpmill. This plant should play an important part in the development of the forest resources of this region. There is a small sawmill at Hartley bay, near the mouth of Douglas channel, but it was not in operation in 1916. Very little cutting has been done in this region, and the forests are practically in their virgin state. What logging was being done in 1915 and 1916 was conducted by handloggers or pre-emptors, who disposed of their small cuts to a sawmill near Prince Rupert. As the cost of towing logs from this district to Vancouver would be about $4.00 per M., local industries must be developed to utilize the forest resources.

Skeena River to Portland Canal Drainage Basin

Two of the largest rivers on the Pacific slope in British Columbia, the Skeena and the Nass, are in this region. Both rise in the interior of the province and cut through the Coast mountains, the lower 80 miles of their courses being on the Pacific side. Skeena river has a length of approximately 325 miles, and, with its tributaries, drains about 18,750 sq. miles, 16,600 sq. miles of the Interior forest and 2,150 of the Coast forest. Nass river is about 275 miles in length and drains an area of about 8,040 sq. miles, 7,680 sq. miles of the Interior forest and 360 sq. miles of the Coast forest. Only the area lying west of the summit of the Coast mountains is discussed in this portion of the report.* In addition to the valleys occupied by these rivers, there are several large inlets in this drainage basin, the most important of which are Portland canal, Observatory inlet and Wark channel.

The Skeena valley is of the same U-shaped formation as the fiords; and, if it were not for the large amount of fresh water pouring into the channel, it would be a salt-water fiord for a distance of at least 50 miles. The Nass valley is of the same type. The Coast mountains at this point take a turn toward the northwest, so that the salt-water inlets of Portland canal and Observatory inlet, though running almost north-and-south and parallel to the coast, are at right angles to the main mountain range. Cross channels connect Portland inlet, which is the lower end of Observatory inlet, with Portland canal, cutting off Wales and Pearse islands. Another through-valley, occupied in large part by Wark channel, extends from Portland inlet to the Skeena, forming the Tsimpsean peninsula. A large river valley, the Ecstall, enters the Skeena from the southeast.

The city of Prince Rupert is situated on Kaien, one of a number of islands near the mouth of the Skeena. Port Simpson lies about 20 miles north of Prince Rupert, and near the northern end of Tsimpsean peninsula. Portland inlet and Observatory inlet are the lower and upper portions, respectively, of the same channel, and total 60 miles in length. Observatory inlet branches at the head into Hastings arm, 18 miles long, and Alice arm, 15 miles long. The

* For area east of the Coast mountains, see pp. 300 to 306.

mining town of Anyox is situated on Granby bay, near the outlet of Hastings arm. Portland canal, which forms the international boundary between Canada and Alaska, is 90 miles long, and in very few places is it more than 1½ miles wide. The city of Stewart is situated at the head of Portland canal. Mining is the most important industry in this locality.

As already mentioned, one of the largest through-valleys in the province occurs in this drainage area, running from the head of Kitimat arm to Nass river. In this valley, Lakelse and Kitsumgallum rivers, are tributary to Skeena river, while Lava lake is tributary to the Nass. The terminal valley at the head of Alice arm, occupied by Kitzault river, extends in a northerly direction about 20 miles. Kshwan river drains the short terminal valley of Hastings arm, and Bear river, at the head of Portland canal, rises in glacial fields within 20 miles of its mouth.

The precipitation in this district varies from 120 inches at the coast to between 50 and 60 at the watershed of the Coast mountains. The winters, especially in the vicinity of the heads of the inlets, are fairly severe, and are accompanied by a considerable fall of snow. The chief areas of agricultural land are situated in the Lakelse-Kitsumgallum valley, where it is estimated that over 100 sq. miles will be available for agricultural purposes when the timber is removed. Some of the bottom-land in this valley, especially on the south side of the Skeena river, is gravelly and of doubtful agricultural value. A promising little settlement has been established at Terrace since the advent of the Grand Trunk Pacific. The chief hindrance to further development of this region is that most of the land is held under either timber license or application to purchase, the owners holding the land for speculative purposes rather than for actual development. The conditions on the Nass river are quite similar to those on the Skeena river, but very little agricultural land occurs west of the summit of the Coast mountains, except on the sandy islands in the river and a narrow stretch of bottom-land on each side of the river. The shore-line of the inlets is generally very steep and rocky, and the timber extends up the steep sides for only one-quarter to one-half mile from the salt water. The flanking mountains are frequently over 5,000 feet high, and are capped with permanent snow and ice. Near the ocean, the timber is usually of poor quality, chiefly scrubby red cedar, yellow cypress and hemlock. Farther back, in sheltered situations, there is considerable good spruce and balsam, and the other species attain a better growth.

The area suitable for agriculture in this portion of the coast is estimated to be about 120 sq. miles, 100 sq. miles of which is still more or less forested.

The stand of saw-timber is estimated to be as follows : Red cedar, 759,920 M.b.f.; hemlock, 3,076,360 M.b.f.; balsam, 1,106,800 M.b.f.; spruce, 1,638,240 M.b.f.; lodgepole pine, 1,680 M.b.f.; yellow cypress, 113,960 M.b.f.; cottonwood, 434,160 M.b.f.; a total of 7,131,120 M.b.f.

The amount of small timber below saw-timber size is estimated to be 990,000 M. b.f., and of the pulpwood species there is about 9,620,000 cords.

CLASSIFICATION OF LANDS IN THE SKEENA RIVER TO PORTLAND CANAL DRAINAGE BASIN

Classes of land	Area, sq. miles	Percentage of entire area
Above merchantable timber-line	4,575	63·8
Below merchantable timber-line :		
Area carrying 30,000 b.f. or more per acre	50	·7
Area carrying between 10,000 and 30,000 b.f. per acre	470	6·6
Area carrying less than 10,000 b.f. per acre (chiefly young growth)	950	13·3
Area incapable of carrying merchantable timber	1,100	15·3
Area suitable for agriculture	20	·3
Total	7,165	....

There are no timber or pulp leases in this district, but approximately 400 sq. miles is held under timber licenses, and about 313 sq. miles has been, or is being, permanently alienated. The total area alienated is, therefore, approximately 713 sq. miles.

There is no Douglas fir in this drainage basin. Heavy stands of cottonwood of good quality occur on the islands and adjoining bottom lands in both the Skeena and the Nass rivers. Spruce is found chiefly on the low lands, though it grows to some extent on the mountain sides. Forest fires have done considerable damage in the eastern part of this district, especially along the Grand Trunk Pacific. Most of the fires in this area originated during the construction of the railway. The reproduction after fire in this district appears to be largely of lodgepole pine, which has not and, perhaps, never will, attain more than pole-wood size.

The chief industries of this district are fishing and mining. Numerous salmon canneries are scattered along the coast at the entrances to the rivers, and the finest halibut fishing on the coast is to be found tributary to Prince Rupert. On Portland canal and Observatory inlet much mining development has been carried on. Stewart was the scene of considerable mining excitement a few years ago, and many promising prospects in this region are awaiting development. At Anyox, the Granby Consolidated Mining, Smelting and Power Co. has established a large smelter. Most of the ore for the smelter is secured from a mine in the immediate vicinity. Good prospects are also being opened up on Alice arm.

The forests in this region have not been exploited to any appreciable extent, and most of the lumber used locally is brought north from Vancouver. In 1916, there were small sawmills at Georgetown, about 15 miles north of Prince Rupert, and at Terrace, on the Grand Trunk Pacific Ry., near the mouth of Kitsumgallum river. These mills were being operated solely for the manufacture of lumber and box material for local use. Logs can be rafted on the lower 50 or 60 miles of the Skeena and on perhaps 30 miles of the Nass. It is doubtful if driving operations above these points would be economical, on account of the numerous channels and shoals in the stream. Eventually, Prince Rupert will become the centre of an extensive lumber industry. Logs

can be towed to Prince Rupert from all points north of Queen Charlotte sound, in the same manner as they are now towed to Vancouver from the areas tributary to Johnstone strait and the strait of Georgia.

Queen Charlotte Islands

This group of islands lies from 50 to 100 miles off the mainland of British Columbia. The north end is almost directly west of Prince Rupert, and the most southerly point is opposite Burke channel. The principal islands of the group, from north to south, are Graham, Moresby and Prevost, while several others of considerable size, Louise, Lyell, Burnaby, etc., lie along the east side of Moresby island. The group forms a rough triangle. The north end of Graham island, which forms the base, is 53 miles wide and the distance from there to cape St. James, which forms the apex of the archipelago, is 156 miles.

Orographically, these islands form a portion of the partially submerged Vancouver Island mountains, which are represented in the south by Vancouver island and on the north by Prince of Wales and other coastal islands of Alaska. Geologically, they are of the same formation as Vancouver island. In some places, the sedimentary rocks of Graham island contain seams of coal. A mountainous axis, commencing near the northwest corner, extends along the western side of Graham island and through the southern islands of the archipelago to cape St. James. Some of the peaks in this range attain a height of 4,500 feet. The north-eastern portion of Graham island is almost flat, seldom exceeding 300 feet above sea. This low land is covered, in places, with glacial till. It is, however, more generally covered by a marine deposit of clays, sands and gravels, indicating successive submergence and elevations of the land.

The nearest land to these islands is Prince of Wales island, Alaska, 45 miles north of Graham island, and on the other side of Dixon entrance. Masset is approximately 80 miles from Prince Rupert, and Skidegate is 120 miles distant from the latter.

Graham island, the largest of the group, is 53 miles wide at the north end, but it narrows to about 25 miles at the south end. The distance from Masset on the north to Skidegate on the south end of the island is 48 miles, and the total land area is approximately 2,370 sq. miles.

Moresby island is separated from Graham island by Skidegate inlet and channel. The latter is so narrow in two places that it is navigable only by canoes. Heavy tidal currents occur in these 'narrows'. The north end of Moresby island is approximately 30 miles wide, and, though much dissected by inlets, it extends in a south-easterly direction for approximately 80 miles. Its total land area is 967 sq. miles. The larger of the other islands of this group are as follows :

Louise island, 124 sq. miles; Lyell island, 92 sq. miles; Kunghit island, 89 sq. miles; Burnaby island, 39 sq. miles; Talunkwan island, 14 sq. miles; Tannu island, 13 sq. miles; Ramsay island, 6 sq. miles.

Opening on the north end of Graham island are two inlets, Masset inlet and Naden harbour. Masset inlet forms a narrow channel for about 17 miles, then opens out into an irregular-shaped inland sea, about six miles wide from north to south and 18 miles long from east to west. As might be expected, the tidal current in the neck of the inlet is very strong, but no dangerous rapids or over-falls occur, and the inlet is navigable for vessels of considerable size. Naden harbour is approached by a funnel-shaped bay, which narrows to an opening less than one-half mile wide, beyond which the harbour expands to about 2½ miles in width by 6 miles in length. This inlet affords excellent natural harbour facilities. The west coast of Graham island affords little shelter for ships. The only safe harbour is Rennell sound, which is situated near the south end of the island. It extends inland about 8 or 9 miles, and, curving to the southward, affords a good shelter from western gales. Cartwright sound, a few miles to the south of Rennell sound, extends inland about 7 miles, but it affords very little shelter from westerly winds. On the east side of Graham island there is no harbour whatever. Skidegate inlet, between Graham and Moresby islands, however, affords excellent harbour facilities.

On the west side of Moresby island several harbours occur, including Inskip channel, Moore channel and Tasoo harbour. The west coast of Graham and Moresby islands has not been thoroughly surveyed, and is seldom visited even by prospectors. The dangers of navigation are so great that the Indians have not established any villages on this side and seldom visit it. On the east side of Moresby island, however, the numerous sheltered channels and deep bays afford excellent protection for shipping and facilitate the exploitation of the natural resources.

The influence of the Japan current renders the climate of the Queen Charlotte islands very equable, and, owing to the absence of high mountains, the precipitation is less than half of what it is on the adjoining mainland. During the winter months, a relatively small portion of the precipitation is in the form of snow.

What is, perhaps, the largest continuous area of agricultural land on the coast of British Columbia is to be found on Graham island. There is approximately 1,290 sq. miles of almost level land, from 200 to 300 feet above sea-level. A large portion of this land is of a muskeg type. The mineral soil is covered by a layer of moss and decaying vegetable matter for a depth of from 3 inches to 2 feet, averaging perhaps 6 or 8 inches. A scrubby growth of timber, composed of red cedar, yellow cypress, hemlock, lodgepole pine and spruce, partially covers the land, leaving many open meadow-like areas between the groves. Where there is sufficient drainage, such as along streams or close to the hore-line of lakes or the salt water, heavy stands of timber are almost invariably found. The cost of bringing the muskeg land under cultivation would be small compared with the cost of clearing heavily timbered lands. On most of this land it would be necessary to provide drainage by shallow surface drains and to remove the covering of moss by burning. Settlements established in the vicinity of Masset and Skidegate inlets have demonstrated that the soil and climate are conducive to the successful growing of all kinds of garden produce

and small fruits, and to the raising of live stock. The agricultural produce from these islands has twice secured the first prize for district exhibits at the annual agricultural fair at Prince Rupert. The settlement of this district has been very greatly retarded, due to the fact that nearly all of the accessible land was taken up under timber licenses, coal licenses or applications to purchase before the attention of prospective settlers was attracted to the district. Hundreds have been turned away, owing to their inability to obtain suitable locations. There is very little actual waste land on Graham island, unless the muskeg areas are classified as such; but as these, though useless for forest purposes, have an agricultural value, they cannot be so classified.

CLASSIFICATION OF LANDS ON THE QUEEN CHARLOTTE ISLANDS

Classes of land	Area, sq. miles	Percentage of entire area
Above merchantable timber-line	284	7·5
Below merchantable timber-line :		
Area carrying 30,000 b.f. or more per acre	335	8·8
Area carrying between 10,000 and 30,000 b.f. per acre	620	16·4
Area carrying less than 10,000 b.f. per acre (chiefly young growth)	965	25·5
Area incapable of carrying merchantable timber	1,570	41·5
Non-timbered agricultural land *	10	·3
Total	3,784	....

* Muskeg land suitable for agriculture is included under that incapable of carrying merchantable timber. This is land capable of producing forests, but which has been burned or cleared so that it is not likely to be again forested. Including the muskeg land, there is about 1,290 sq. miles (34·1 per cent) which may be developed for agricultural purposes.

Of this area, approximately 680 miles is held under timber licenses, 16 sq. miles under timber lease and 468 sq. miles has been either Crown-granted or is held under application to purchase or pre-empt. The total area alienated is, therefore, approximately, 1,164 sq. miles.

The total stand of saw-timber is estimated to be as follows : Red cedar, 3,729,100 M.b.f.; hemlock, 5,712,700 M.b.f.; spruce, 4,817,800 M.b.f.; lodgepole pine, 31,000 M.b.f.; yellow cypress, 465,100 M.b.f.; a total of 14,755,700 M.b.f.

Of this amount, approximately 6,500,000 M.b.f. is on Graham island and 8,253,700 M.b.f. on Moresby and other islands. In addition to the saw-timber, there is estimated to be about 1,210,000 M.b.f. of small timber, chiefly cedar poles and pulpwood. Of the pulpwood species, there is estimated to be 16,400,000 cords.

The distribution of the merchantable timber on the Queen Charlotte islands is very largely determined by drainage. On the hillsides and along the shores and streams very heavy stands, yielding from 25 M. to over 100 M., occur generally, but on the flat land on Graham island little or no merchantable timber is found. The heavy stands do not, as a rule, extend back more than a mile—and, frequently, less than a mile—from the shore-line or edges of the streams. The better drainage afforded by the more mountainous

topography on the southeastern portion of Graham island, and on Moresby and the adjacent islands, results in more extensive stands of high-grade timber.

The Sitka spruce of the Queen Charlotte islands is undoubtedly of the finest quality to be found on the coast, especially for aeroplane construction. It grows to immense sizes, frequently 6 to 8 feet in diameter, and from 150 to 200 feet high. Single trees containing over 50 M. feet have been cut. The wood is, as a rule, fine-grained, tough, strong and elastic. The large trees yield a high percentage of clear lumber, in spite of the fact that spruce is a shade-enduring species and does not readily shed its branches.

Most of the spruce purchased by the Imperial Munitions Board for aeroplane construction came from the Queen Charlotte islands. Though Sitka spruce occurs generally throughout the coast region, it seldom forms a large proportion of the stand except on these islands. There, it frequently comprises over thirty per cent of the stand on quite large areas.

The hemlock is, as a rule, superior in quality to that found in the southern portion of the province, and is an important species on these islands. The red cedar, though it grows to large sizes, is frequently not very sound, and a considerable proportion of it is more suitable for the manufacture of shingles than lumber. The yellow cypress grows in the swampy flat lands or on the hill tops, and, though frequently reaching merchantable size, the trees are usually of a scrubby growth, tapering very rapidly from the butt. Lodgepole pine may be used for mining props, fuel, etc., but could not be considered of much value as saw-material. The absence of balsam from these islands is peculiar, since it occurs in conjunction with the hemlock and spruce on the adjacent mainland, but no report of its presence has been received, nor has it been seen by the author of this chapter on several visits he has made to the islands.

Prior to development of the aeroplane spruce industry, four small mills had been erected on Masset inlet and one on Skidegate inlet, but their operations were very limited. During the construction of the Grand Trunk Pacific railway, ties as well as some lumber were shipped to Prince Rupert. The demand for aero-lumber gave a great impetus to the lumber industry on the islands. The mills already established were improved and five new mills were erected. A large number of logging camps were opened up to supply the local mills, and the mills on the mainland. The logs were successfully towed across Hecate strait in Davis rafts and undoubtedly the pulpmills on the mainland will continue to secure a considerable amount of their log supplies from these islands. In the production of aero-lumber only the clear, straight-grained material was accepted. Thus, selective logging was necessary, and only the best trees have been removed, leaving, in many cases, good stands for pulp or commercial lumber.

Prospecting for oil is being conducted on the west side of Graham island. For a number of years, copper has been mined at the southern end of Moresby island. In addition to their other resources, the waters in the vicinity are noted as fishing grounds for halibut, salmon, herring and cod, and a whaling station has been established in Naden harbour. The lack of adequate transportation facilities has been one of the greatest deterrents to the development

of the resources of these islands. When direct trade connections are established between Prince Rupert and the Orient, which will necessitate the passage of the steamers along the north shore of Graham island, this situation will, in all probability, be ameliorated to a certain extent. There is perhaps no portion of the province which offers such a rich field for development as do the Queen Charlotte islands.

Appendix I

(Specimen)

PROVINCE OF BRITISH COLUMBIA

FOREST BRANCH, DEPARTMENT OF LANDS

PULP LICENSE No. 605

Timber Sale Contract

THIS INDENTURE, made the day of A.D. 191 , between His Majesty the King (herein represented and acting by , Minister of Lands for the Province of British Columbia), who, with his heirs and successors, is hereinafter called "the Lessor," of the one part, and

who, together with executors, administrators, successors, and assigns, is hereinafter called "the Lessee," of the other part.

WITNESSETH that, in consideration of the payments and stipulations to be made and observed by and on the part of the Lessee and of the Lessee's offer to purchase made under the said Act, the Lessor doth hereby grant unto the Lessee, under and subject to the provisions of Part III of the "Forest Act," and for the term and subject to the reservations and conditions hereinafter provided, a license to cut and remove all the merchantable timber upon an area which is agreed to comprise *460* acres, situated and described as follows, and shown upon the map annexed and thereon coloured red :

No. 605

Commencing at the S.E. corner of T.L. 3419, Range 3, Coast ; thence N. 20 chains ; E. 40 chains ; S. 20 chains ; E. 60 chains ; S. 20 chains ; E. 10 chains ; S. 20 chains ; W. to the shore ; thence north-westerly along shore to the point of commencement.

In consideration whereof the Lessee hereby covenants, promises and agrees with the Lessor that the Lessee shall pay to the said Minister of Lands the several sums at the times and in the manner following, namely :—

(1.) An annual rental, based on *460* acres, at the rate of *10.937* cents per acre, amounting to *$50.31*, further payments to be made annually in advance on the *first* day of *January* in each year hereafter during the continuance of the license hereby granted : Provided that such annual rental is to be reduced in each year by the omission from its computation of six hundred and forty acres or any multiple thereof when said six hundred and forty acres or multiple thereof has been logged in the preceding year, as proved to the satisfaction of the said Minister.

Provided that, in respect of any saw-timber cut or removed from any area in respect of which half-rental is being paid under the provisions of this section, there shall be due and paid per thousand feet of such saw-timber, in addition to royalty on saw-timber, an amount equivalent to the rental charge that would have been paid per thousand feet had the saw-timber aforesaid been held under special timber license issued at the same date as the pulp license in question, fifteen thousand feet, board measure, of saw-timber being taken as the equivalent of one acre in computing said rental charge.

(2.) All forest-protection dues as provided in the "Forest Act" and amendments, payable annually in advance on the *first* day of *January* in each year during the life of this contract.

(3.) Royalties and the cost of scaling, payable as follows :—
Royalties as provided in the Statutes, which must be paid within sixty (60) days from the date of Scale and Royalty account.

(4.) The cost of cruising, surveying, and advertising incident to this contract, being the sum of *$45.00*.

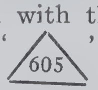
(5.) A stumpage price as follows :

Douglas fir	*$ .95 per M B.F.*
Red cedar	*1.05 " "*
Spruce	*.50 per cord*
Hemlock	*.35 "*
Balsam	*.35 "*

Payable as follows :—

To be paid immediately upon receipt of stumpage account.

And the Lessee further covenants, promises, and agrees to cut and remove said timber in strict accordance with the following conditions and with all regulations and provisions governing timber sales in the "Forest Act" and amendments :—

(1.) No timber will be removed from the sale area until it has been conspicuously marked with the following registered mark issued for this timber sale : " 

"

(2.) No unnecessary damage will be done to young growth or to trees left standing. So far as practicable, trees will be felled uphill, and no trees will be left lodged in the process of felling. If trees designated to be left standing are badly damaged through carelessness during the process of logging or are cut, they will be paid for at the rate of *$1.50* per M.

(3.) Stumps will be cut so as to cause the least practicable waste, and will not be cut higher than the diameter of the tree at the point where it is cut, and in no case higher than *30* inches on the side adjacent to the highest ground, except in unusual cases in the discretion of the officer of the Forest Branch in charge.

(4.) The following trees will be cut :—
All trees containing 50% of their contents in merchantable timber or pulp wood, fourteen inches and over in diameter as directed by the officer of the Forest Branch in charge.

(5.) No timber will be manufactured or sold until it has been properly scaled, as provided in the "Forest Act" and amendments, and in accordance with the following special provisions :—
All timber will be scaled by an official or acting official scaler, before being removed from the sale area, or from booms adjoining the sale area, unless other arrangements are made in writing with the District Forester, Prince Rupert.

(6.) All trees will be utilized to as low a diameter in the tops as practicable, so as to cause the least waste, and to the minimum diameter of *10* inches when merchantable in the judgment of the officer of the Forest Branch in charge. Log lengths will be varied so as to provide for the complete utilization of merchantable timber.

(7.) Merchantable trees designated for cutting which are left uncut, timber wasted in tops and stumps, trees left lodged in the process of felling, and any merchantable timber which is cut and not removed from any portion of the cutting area after logging on that portion of the cutting area is completed shall be scaled, measured, or counted as hereinbefore provided, and paid for as follows :—
At the rate of $1.50 per thousand feet, B.M., such sums to be paid upon receipt of bill.

(8.) Brush will be disposed of as follows :—
As directed by the District Forester, Prince Rupert.

(9.) The license hereby granted is to be renewable yearly upon the payment of the annual rental hereby reserved, at the time and in the manner hereinbefore specified, during the term of *30* years from the date of this contract next ensuing: Provided that all timber is to be cut and removed before the *first* day of *January, 1947*; and, further, that the amount cut in any one year under this contract shall not be less than *1,000 cords*, except with the written consent and approval of the said Minister.

(10.) Provisions for fire protection :—
As provided in the Forest Act, Part XI, Sections 104 to 133, inclusive.

The Lessee agrees that the sum of $*100.00*, which accompanied his tender for timber covered by this contract, shall be held until the completion of the contract ; and provided that the contract has been faithfully carried out to the satisfaction of the Minister of Lands will be refunded ; otherwise this amount will be held until the requirements have been fulfilled by the Lessee, and then refunded ; or otherwise will be forfeited :

Provided further that all timber cut under this contract shall be used in this Province, or be manufactured in this Province into boards, lath, shingles, or other sawn lumber, to such an extent to be of use in the trades without

further manufacturing, except in the case of piles, telegraph and telephone poles, ties, and crib timber, which may be exported under an Order in Council.

The decision of the Minister of Lands will be final in the interpretation of any of the terms and conditions of this contract.

The Forest Officer in charge, by giving notice to that effect in writing to the Lessee, or to the person in charge of logging operations upon the area, may suspend any logging operation conducted upon this area, should violation of any of the terms or conditions of this contract have occurred ; and such violation shall render this contract liable to cancellation by the Minister of Lands.

Provided further that the interest, rights, and privileges of the Lessee in the said hereditaments, tenements, and premises shall be construed as subject always to all the provisions of the "Forest Act" and amendments thereof.

In witness whereof the parties hereto have hereunto set their hands and seals the day and year first above written.

Signed, sealed and delivered on behalf of the within-named Lessor in the presence of—

SEAL

Deputy Minister of Lands.

Signed, sealed, and delivered on behalf of the within-named Lessee in the presence of—

SEAL

(Lessee or Purchaser.)

Appendix II

VOLUME TABLES

Compiled by the British Columbia Forest Branch

Volume Table for Douglas Fir

Giving merchantable contents, British Columbia rule, under present conditions, with no allowance for breakage or defect. Compiled from measurements taken of 726 trees on the lower coast.

Diameter at breast height	Short	Medium	Tall	Diameter at breast height	Short	Medium	Tall
Inches	Board feet	Board feet	Board feet	Inches	Board feet	Board feet	Board feet
22	350	440	600	44	2,250	3,020	3,810
24	420	560	750	46	2,550	3,370	4,230
26	510	710	920	48	2,875	3,750	4,675
28	610	880	1,130	50	3,225	4,150	5,130
30	730	1,075	1,375	52	3,580	4,565	5,610
32	890	1,280	1,650	54	3,960	5,000	6,090
34	1,060	1,520	1,955	56	4,350	5,475	6,580
36	1,250	1,770	2,280	58	4,775	5,950	7,075
38	1,470	2,050	2,640	60	5,230	6,460	7,575
40	1,700	2,350	3,010	62	5,750	7,000	8,080
42	1,970	2,675	3,400				

Volume Table for Cedar

Giving merchantable contents, British Columbia rule, under present conditions, with no allowance for breakage or defect. Compiled from measurements taken of 354 trees on the lower coast.

Diameter at breast height	Short	Medium	Tall	Diameter at breast height	Short	Medium	Tall
Inches	Board feet	Board feet	Board feet	Inches	Board feet	Board feet	Board feet
20	190	290	410	42	1,440	1,895	2,340
22	260	375	530	44	1,650	2,125	2,600
24	335	475	660	46	1,865	2,370	2,875
26	420	585	800	48	2,090	2,640	3,175
28	510	705	950	50	2,330	2,925	3,515
30	600	835	1,115	52	2,580	3,220	3,865
32	710	975	1,300	54	2,835	3,525	4,250
34	825	1,125	1,485	56	3,195	3,840	4,650
36	960	1,290	1,685	58	3,360	4,150	5,080
38	1,100	1,475	1,890	60	3,630	4,480	5,530
40	1,260	1,675	2,100				

Volume Table for Hemlock

Giving merchantable contents, British Columbia rule, under present conditions, with no allowance for breakage or defect. Compiled from measurements taken of 207 trees on the lower coast.

Diameter at breast height	Short	Medium	Tall	Diameter at breast height	Short	Medium	Tall
Inches	Board feet	Board feet	Board feet	Inches	Board feet	Board feet	Board feet
16	220	300	410	30	1,030	1,440	1,730
18	300	410	530	32	1,230	1,680	2,040
20	385	530	670	34	1,450	1,950	2,380
22	480	670	830	36	1,680	2,260	2,780
24	590	830	1,020	38	1,930	2,580	3,200
26	715	1,010	1,235	40	2,200	2,920	3,620
28	865	1,210	1,470				

Appendix III

BRITISH COLUMBIA LOG SCALE

(Condensed)

Diameter of small end of log in inches	Length of log in feet								
	10	12	14	16	20	24	28	32	40
10	34	41	48	55	69	83	96	110	138
12	53	63	73	84	105	126	147	168	210
14	74	89	104	119	149	178	208	238	298
16	100	120	140	160	200	240	280	320	400
18	129	155	181	207	259	311	362	414	518
20	163	195	228	261	326	391	456	521	652
22	200	240	280	320	400	480	560	640	800
24	241	289	337	386	482	578	675	771	964
26	286	343	400	457	571	686	800	914	1,145
28	334	401	468	535	668	802	936	1,070	1,337
30	387	464	541	619	773	928	1,082	1,237	1,546
32	443	531	620	708	886	1,063	1,240	1,417	1,771
34	503	603	704	804	1,005	1,207	1,408	1,609	2,011
36	567	680	793	906	1,133	1,360	1,586	1,813	2,266
38	634	761	888	1,015	1,268	1,522	1,775	2,029	2,536
40	705	847	988	1,127	1,411	1,693	1,975	2,258	2,822
42	781	937	1,093	1,249	1,561	1,874	2,186	2,498	3,123
44	860	1,032	1,204	1,376	1,719	2,063	2,408	2,751	3,439
46	943	1,132	1,320	1,508	1,885	2,262	2,639	3,016	3,770
48	1,029	1,239	1,441	1,649	2,058	2,470	2,822	3,293	4,117
54	1,312	1,574	1,837	2,099	2,624	3,148	3,673	4,198	5,247
60	1,629	1,955	2,280	2,606	3,258	3,909	4,561	5,212	6,515
66	1,980	2,376	2,772	3,168	3,960	4,752	5,544	6,336	7,920
72	2,366	2,839	3,312	3,785	4,731	5,677	6,624	7,570	9,462

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